THE PROJECTED EFFECTS OF A PAPERLESS INFORMATION SYSTEM ON THE PRODUCTIVITY OF THE AIR FORCE INSTITUTE OF TECHNOLOGY EVALUATIONS AND ADMISSIONS DIVISION

THESIS

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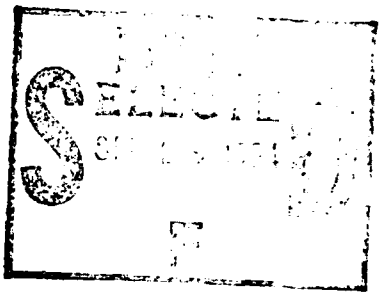

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THESIS

Presented to the Faculty of the School of Logistics and Acquisition Management
of the Air Force Institute of Technology
Air Force Education and Training Command
In Partial Fulfillment of the
Requirements for the Degree of
Master of Science in Systems Management

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Richard A. Bihary
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Abstract

The Air Force Institute of Technology Admissions/Registrar Directorate (AFIT/RR) has a need to improve and expand services using a smaller operating budget. One promising solution is to eliminate the paperwork required to perform the AFIT/RR functions. By eliminating paperwork, AFIT/RR expects to improve productivity and customer services while reducing the storage costs, supply costs, and time required to complete functions. To assist AFIT/RR managers in evaluating alternatives, this thesis determines the projected effects of a paperless information system affects the productivity of the Air Force Institute of Technology Evaluations and Admissions Division (AFIT/RRE).

In administrative and service organizations productivity is difficult to define and measure. For the purposes of this thesis the DOD definition is used. This definition of productivity focuses on the efficiency with which organizations utilize labor resources to accomplish their missions. Based on these definitions, the hours per unit of work (HPU) was chosen as the measure of productivity. Next, several paperless techniques common to information systems of today are discussed. Furthermore, these techniques demonstrate productivity savings that are useful for the needs of this thesis. Finally, chapter two presents the techniques and productivity savings found in two similar applications. These applications are particularly relevant to AFIT/RR because the functions of records management; data storage; request processing (by both paper and phone); information

processing for determinations, approvals, and so on; work process monitoring; transmitting of replies; and so on are virtually the same.

The methodology primarily consisted of five research objectives and techniques for accomplishing the objectives. The first objective defines productivity and develops measures of productivity as they relate to AFIT/RRE. The second objective defines the work processes used by AFIT/RRE to accomplish their mission, determines that only a subset of the processes require measuring, and finally measures the productivity of the selected processes. Data collected for objective two consists of work process flow charts, frequency values, time requirements, and discussions from workers on the details of the selected processes. Next, paperless techniques are applied to the current information system to develop a representative paperless information system model. The fourth objective remeasures the productivity of the selected processes subject to the paperless information system model. The final objective compares and contrasts the two sets of measurements.

From these calculations several conclusions are made. AFIT/RRE can expect to receive a productivity increase of approximately 65 percent from implementing a paperless information system. This value is calculated from a weighted average of the four processes selected from the Pareto analysis. However, based on the methodology used to calculate this value, an expected range of productivity increase is more appropriate. This range is 32 to 75 percent. Furthermore, additional benefits such as reduced document idle time, improved document and decision quality, increased manager control, and others are possible.

THE PROJECTED EFFECTS OF A PAPERLESS INFORMATION SYSTEM ON THE PRODUCTIVITY OF THE AIR FORCE INSTITUTE OF TECHNOLOGY EVALUATIONS AND ADMISSIONS DIVISION

I. Introduction

The purpose of this thesis is to determine the nature and extent to which a paperless information system would affect the productivity of the Air Force Institute of Technology Evaluations and Admissions Division (AFIT/RRE). This thesis contributes to a larger AFIT Admissions/Registrar Directorate (AFIT/RR) goal to determine what benefits are possible from implementing a paperless information system and to measure these benefits. This thesis develops a productivity estimation without using a prototype system or simulation. Chapter One defines the terms used throughout the thesis and provides the background that led to this research effort. Next, the rational for selecting the thesis' scope and underlying assumptions is presented. Finally, the chapter outlines the research objectives and gives an overview of the remaining chapters in the thesis.

Definition of Terms

For this research effort, the term *information system* is defined as the facilities, equipment, and connections needed for the processing and transfer of information into, out of, and within an organization. The functions of administrative and service organizations are typically supported by the processing accomplished in an information

system. Therefore, for this effort, a *paperless information system* is simply an information system that does not substantially rely on paper for the processing and transfer of information. Of course, no organization can completely eliminate all paperwork at the present time. However, any organization that eliminates the use of most of the paperwork required for the performance of its primary functions is considered paperless for the purpose of this thesis. Additionally, information systems use various techniques as a means to accomplish the processing and transfer of information. Even though there is a standard set of techniques used in most systems, the specific techniques used in different information systems vary. The term *paperless techniques* refers to any techniques that allow for the processing and transfer of information without the use of paper. Finally, because many administrative and service organizations receive mass quantities of paper for processing, one of the important paperless techniques is to use imaging to convert paper items into electronic duplications of the item. *Imaging* is the process of creating an electronic image of a paper item by optically scanning it.

Background

Over the last few years, universities have faced worsening financial situations that in many cases have resulted in the elimination of services (Lancaster and Strouble, 1992:19). AFIT also faces the problem of coping with recent and planned budget cuts (Koz, 1993). At the same time, the Air Force is striving to improve services to internal and external customers through several quality programs. For AFIT, further complications arise from new agreements with Wright State University and the University of Dayton, and policies on collecting part-time student tuition which may actually increase

the AFIT/RR workload. This presents AFIT/RR with a difficult problem: how to improve and expand services with a smaller operating budget. One promising solution is to eliminate the paperwork required to perform the AFIT/RR functions.

By eliminating paperwork, AFIT/RR expects to improve productivity and customer services while reducing the storage costs, supply costs, and the time required to complete functions. Initially, AFIT/RR is developing a paperless environment for the Records and Systems Management Division. Imaging and mass storage technologies are being used to develop this paperless environment (Air Force Institute of Technology, 1993:6). To support AFIT/RR managerial decisions, analysis is needed to determine where the expected benefits from this program will occur. Data on the extent or magnitude of the benefits is needed so that specific funding comparisons can be made with other competing programs and requirements. Furthermore, analysis is needed to determine whether the initial program should be expanded to other divisions within AFIT/RR. Air Force experience with the implementation of similar systems shows they are typically based on a lack of factual information concerning the actual quantitative and qualitative benefits (Warren, 1986:37). With limited budgets and increasing demands, relevant costs and benefits data are needed for managers to make decisions that provide the greatest return on expended resources.

Research Objectives

In support of AFIT/RR decision makers, the goal of this thesis is to determine the nature and extent to which a paperless information system affects the productivity of the

Air Force Institute of Technology Evaluations and Admissions Division (AFIT/RRE). To solve the stated problem, five investigative objectives are identified.

1. Define productivity and develop measures of productivity as they relate to AFIT/RRE.

2. Define the work processes used by AFIT/RRE to accomplish their mission, determine whether a subset or all of the processes must be measured, and finally measure the productivity of the selected processes.

3. Apply paperless techniques to the current information system to develop a representative paperless information system model.

4. Estimate the productivity of the selected processes subject to the paperless information system model.

5. Compare and contrast the two sets of measurements.

The product from accomplishing these objectives is determination of the nature (primarily from the identified paperless techniques) and extent (from comparing the measures of productivity) to which a paperless information system affects the productivity of the AFIT/RRE.

Scope

Due to the vast number of factors associated with a paperless information system and the many related benefits, this thesis team limited its efforts to the benefits provided by increased productivity within one division at AFIT/RR. The rational for limiting the scope to productivity and selecting one division is provided in the following paragraphs.

Defining a paperless information system that provides identifiable benefits in an organization the size of AFIT/RR is a complex undertaking which requires a great body of knowledge and expertise. According to one source, the real value of any information

system, paperless or not, may come from something other than productivity (Smith, 1987:8-9). This value could come from intangible benefits such as better communications between workers or increased morale. Even though it is true that there are other benefits, the experiences of this thesis team lead us to postulate that productivity is where AFIT/RR will find cost savings value for functions other than records management and data storage. Another source states that implementing technology is necessary, but not sufficient for productivity growth. The organization and work processes must be structured to take advantage of the technology (The Payoff from Information Technology, 1993:130). According to Dykman, good systems analysis has always been a critical step in the development of a beneficial information system. Furthermore, modern technology has allowed system developers to do haphazard systems analysis that results in functioning, but inadequate information systems (Dykman, 1991:6). In order to accomplish the tasks just discussed for a beneficial information system, knowledge and expertise from disciplines such as Business Process Improvement, Management Information Systems, Office Automation, Information Engineering, Organizational Behavior and others are required. Combined, Capt Bihary and Capt Shrader have over 20 years of experience in maintaining, operating, networking, and supporting computers in an office environment. However, to acquire a sufficient level of knowledge and expertise in all the previously identified disciplines is beyond the capabilities and resources of this team. Therefore, this thesis team focused on applying appropriate paperless techniques to the functions/steps of the currently existing AFIT/RRE work processes. These new paperless work processes form the basis for a paperless information system. Related concepts from the previously

identified disciplines are provided as required for completeness and to aid in the extension of our methodology to a real-life paperless information system.

The Evaluations and Admissions Division of AFIT/RR was chosen as the subject for this thesis. Because AFIT/RR is initially implementing a paperless environment for the Records and Systems Management Division, this division would appear the likely choice as the subject of this thesis. However, the Records and Systems Management Division is the subject of a similar thesis effort and the benefits for the records management and data storage functions accomplished by this division are already more fully understood in the information systems industry. The affect of a paperless information system on the other divisions within AFIT/RR is not as well understood or defined. The Evaluations and Admissions Division, AFIT/RRE, was chosen due to the significant amount of work accomplished in the division. Only the functions related to AFIT/RRE's mission are included as part of this research. Other functions, such as additional duties, personnel actions, and so on are not included in this effort.

Assumptions

We made two assumptions in this research effort. The first assumption is that except for the paperless process changes, all other factors that affect productivity are held steady or at least in the aggregate don't change the level of productivity. In reality a manager would have to confront many other factors that affect productivity and then provide solutions for these. This assumption allows us to study the impact of only the paperless techniques on the productivity of the processes without having to monitor and account for the impact of various other productivity factors. To exclude these other

factors that affect productivity, our methodology uses a static productivity measurement to take a "snapshot" of productivity at a fixed point in time and then applies theoretical or expected productivity techniques. A further discussion of other factors that affect productivity and the static measurement is included in Chapter Two. The second assumption is that the descriptions of work processes by AFIT/RRE in interviews and documentation are valid. This includes the estimates of the number of times each process is performed and the amount of time it takes to perform each process. A review of the process data for currency is appropriate and within the scope of this thesis. A further discussion of this issue is included in Chapter Four.

Overview

The second chapter of this thesis covers the review of literature relating to this thesis. This literature review includes research on the functions of AFIT/RR, definitions and measures of productivity, documentation of work processes, paperless techniques, and how paperless information infrastructures have increased productivity in other organizations.

The third chapter of this thesis presents the methodology that is used to conduct this research. This chapter provides a detailed explanation of the research objectives and how these objectives are accomplished.

The fourth chapter presents the data collected from AFIT/RRE and provides the results of accomplishing the research objectives. Details of the selected work processes are provided. Additionally, data on the productivity measures, work process selection, and work process transformation into paperless process are presented.

The fifth chapter of the thesis reviews the main points. After the review, conclusions and recommendations are presented based on the total research effort.

II. Literature Review

Introduction

The literature review for this thesis effort covers several areas. The first area is research on the mission and the functions of each of the three divisions of AFIT/RR. The next area is research into the area of productivity including definitions, measures, and other factors of productivity. The third area is a discussion of the proper method for documenting work processes. The fourth area is a review of possible paperless techniques for application to AFIT/RR. The final area is an investigation of the nature and extent to which paperless information systems have increased productivity in organizations with functions similar to those of AFIT/RR.

The *Funk and Wagnalls Standard Dictionary* defines the registrar as "a college or university officer who records the enrollment of students, their grades, etc." (Funk and Wagnalls Standard Dictionary, 1993:668). O'Rear, in his research on the registrar, expands this definition by stating:

> It should be understood at the outset, that throughout this study the work of the registrar is intended to include both those duties which he performs as an individual and those performed by any members of a staff under his supervision and direction.... (O'Rear, 1925:2)

He further expands the definition by continuing "... in accordance with general usage in a vast majority of schools, this study uses the one title of registrar as inclusive of those individuals who operate as recorders, examiners, and other comparable officials" (O'Rear, 1925:2).

In most colleges and universities, the registrar and the registrar office perform many duties beyond recording the enrollment of students and their grades. Owen compiled a list of over seventy duties that more than 25 percent of the registrars he surveyed performed on a regular basis (Owen, 1967:113-123). Like other college and university registrar offices, AFIT/RR also performs many duties. Therefore, research of the missions and functions of AFIT/RR was necessary to ensure that the paperless information system can accomplish all required duties.

Functions of the AFIT Admissions/Registrar Directorate

AFIT/RR is organized into three separate operational divisions: the Records and Systems Administration Division, the Registrar Division, and the Evaluations and Admissions Division.

Records and Systems Management Division (Detachment 2, 3810 Management Engineering Squadron, 1992:3-7). The Records and Systems Management Division's primary mission is to maintain the academic records for all Air Force officers including officers in the Air Force Reserves and the Air National Guard. The Division also inputs and monitors the accuracy of officer academic data in the Headquarters Air Force Military Personnel Center (HQ AFMPC) Personnel Data System. In addition, the Division performs several other functions. These functions include:

a. Providing administrative support to the Directorate including distributing incoming mail, preparing correspondence, and maintaining publications.

b. Serving as the focal point for the Directorate's computer resources. This includes the responsibilities for the acquisition, installation, performance, and maintenance of the computer hardware and software.

c. Management of the computers and terminals dedicated for use with the HQ AFMPC Personnel Data System.

d. Monitoring the Training Management System including distributing the system's products.

e. Updating, coordinating, and publishing the AFIT Catalog.

Registrar Division (Detachment 2, 3810 Management Engineering Squadron, 1992:3-4). The Registrar Division's mission is to maintain all resident students' records from the date of each student's admission until 50 years after the student's graduation. This includes recording grades, producing transcripts and academic reports for students and instructors on a quarterly basis. The Division also performs several other functions. These functions include:

a. Admission and registration of students attending AFIT in residence.

b. Producing class schedules.

c. Issuing resident graduate and professional continuing education transcripts.

d. Maintaining AFIT's five year calendar.

e. Maintaining AFIT's suspense calendar.

f. Planning and conducting graduation ceremonies.

Evaluations and Admissions Division (Detachment 2, 3810 Management Engineering Squadron, 1992:3-10). The Evaluations and Admissions Division's mission is to manage the process of admitting students to the appropriate AFIT program (both resident and civilian institute). This process includes the evaluation of Air Force officers' academic records to determine eligibility for the various AFIT education programs and the

initiation of assignment actions for admitted students. The Division also performs other functions. These include:

a. Providing education guidance to prospective AFIT students.

b. Maintaining a library of college catalogs.

c. Preparing and distributing information on the various AFIT programs.

d. Maintaining admission records.

These functions of the individual divisions make up the collective function of the Admissions/Registrar Directorate.

Productivity in Administrative and Service Organizations

In the competitive 1990s, there comes a time when an organization's management must address increases in productivity. This may be due to cuts in funding, reduced sales, reduction in personnel, or a variety of other reasons. According to economists Wallace Peterson and Paul Estenson, "there is no single economic magnitude of greater importance to the overall material well-being of the nation than productivity..." (Peterson and Estenson, 1992:5).

For manufacturing organizations, productivity is normally a simple issue to define and measure. They measure productivity by using the amount of output manufactured and the amount of hours spent making that output. Both of these are easy to identify and measure in the normal manufacturing setup. In addition, changes in productivity are often easy to predict and explain. Items like new equipment, additional worker training, and even pay increases can result in immediate increases in productivity. However, in administrative and service organizations the concept of productivity is not as easy. To

measure productivity, the manager must have a basic understanding of productivity. Developing this understanding of productivity requires the manager to have a basic knowledge of the definition of productivity, limitations of productivity measures, difficulties in measuring productivity, planning for measuring productivity, methods of measuring productivity, and other factors that effect productivity.

Definitions of Productivity. There are many definitions of productivity. Most of the definitions are various measures of outputs divided by inputs. Informally, most people define productivity as something like doing the right things and working. A widely accepted formal definition of productivity is "reaching the highest level of performance with the lowest possible expenditure of resources" (Issues in White Collar Productivity, 1984:64).

Many people confuse the term productivity with efficiency and effectiveness. To clarify the differences, many organizations often use the following definitions (Byers and Waylett, 1984:4):

> Productivity: a combination of efficiency and effectiveness.
>
> Efficiency: producing the greatest results with minimum waste of resources (Output/Input).
>
> Effectiveness: the ability to attain the goals of the organization.

One of the largest service organizations in this country is the Department of Defense (DOD). The DOD divides productivity into two parts. These parts are total resource productivity and labor productivity. DODI-5010.34 provides definitions of these two parts of productivity.

> The efficiency with which organizations utilize all types of fund resources (operating and investments) to accomplish their mission represents total resource productivity. The efficiency with which organizations utilize labor resources to accomplish their missions represents labor productivity. (Department of Defense, 1975:1)

Since both of these definitions use the term efficiency, DODI 5010.34 clarifies the definitions by providing a definition of efficiency as a means of accomplishing the right things with the lowest possible expenditure of resources (Department of Defense, 1975:1). The measure of effectiveness is a separate, but related, issue covered by the many different quality efforts in use today. These definitions, which are adopted for this thesis, provide a basic understanding of productivity in DOD organizations and are applicable to other administrative and service organizations. Before discussing productivity measurement, a word of caution about limitations helps establish boundaries for analysis.

Limitations of Productivity Measures. According to the National Research Council, productivity statistics can have a disastrous effect on an organization when there are no clear measures of output. Similarly, processes that resist being properly defined produce unreliable and potentially harmful data (National Research Council, 1979:33). Management pressure to define clear and measurable objectives can cause less important easily quantifiable objectives to overshadow more important unquantifiable objectives. A good example of this is "excessive attention to the learning of specific skills in professional schools may allow less time for the development of diagnostic judgment or ethical standards" (National Research Council, 1979:33). Organizations that lack empirically demonstrable techniques may substitute socially acceptable processes. For example, trying to measure the productivity of a social worker attempting to guide a juvenile in

trouble could produce data that destroys the confidence of the juvenile and the social worker and lead to complicated and more unproductive processes. A careful manager will avoid these dangers and should request the assistance of productivity professionals. In addition to the limitations to productivity measures, managers should be aware of the other difficulties in measuring productivity.

Difficulties in Measuring Productivity. Measuring productivity can be a difficult task. Some of the difficulty is attributable to a lack of standard definitions and a lack of knowledge by many managers on what productivity is or how to measure it (Issues in White Collar Productivity, 1984:8). The three main difficulties often associated with measuring productivity are employee involvement, deciding what to measure, and who does the measuring.

Employee Involvement. Employee involvement is critical to the measurement of productivity. How the management of the organization treats changes in productivity can have a big influence on the amount of employee involvement. In Japanese firms, the consequences of improved productivity are always positive. American firms, on the other hand, have tended to make the consequences of increased productivity negative for those involved (Sink and Tuttle, 1989:182). To many employees in American organizations, productivity is a job security issue with reduced head count being the consequence of improved productivity. Consequently, when measuring productivity involves employees of the organization, managers should attempt to address the overall issue of job security (Gaines and Nelson, 1993:21-22).

Deciding What to Measure. Deciding exactly what to measure can also be difficult. In administrative and service organizations, determining the actual output of the organization may require brainstorming sessions. Services may be hard to quantify as output. The best solution in most cases is to look for products (such as completed forms or reports) that indicate the completion of a service or even an action that is a step towards the completion of the service (Christopher, 1985:3.50-3.53).

Who Does the Measuring. Different people have different perspectives on what is the best measure of productivity for the organization. Accountants may decide that financial indicators such as return on investment may be the best way to measure productivity, whereas engineers may decide that physical measures are more appropriate (Lawlor, 1985:34, 38). Managers must ensure the person doing the measurements understand exactly what should be measured.

Finally, with the definitions of productivity, limitations of productivity measures, and difficulties in measuring productivity as a foundation, the manager is ready to begin the process of measuring productivity.

Planning for Measuring Productivity. Before planning to measure productivity, the first question to ask is why measure productivity? There are at least three important reasons to measure productivity (Christopher, 1985:1.90; Sink and Tuttle, 1989:141-142).

> (1) Measurement provides an information base for goal-setting and for monitoring of achievement performance. Information is what changes us toward the goals we seek. Measures provide us that information.
>
> (2) Measurement can reveal problem areas that would not otherwise be seen.

(3) Measures can be a source for learning and for participation. Productivity improvement results from what all employees do. It can't be invented as a technique and arbitrarily installed. Developing and employing measures can provide a way for drawing on and motivating all company human resources.

After understanding why you are measuring productivity, you must define a process to use to measure productivity. One common process used to measure productivity involves following eight basic steps (Christopher, 1985:1.147).

1. Define the purpose (mission).

2. Describe the outputs produced when the purpose is successfully achieved.

3. Determine measures for the outputs.

4. Identify input(s) used to create the outputs.

5. Determine measures for the inputs.

6. Develop productivity measures (outputs/inputs).

7. Set objectives.

8. Monitor the measures, providing feedback information at all performance levels.

These steps should all be accomplished by establishing a dialog between the measurer and the persons responsible for the inputs and outputs of the organization being measured (Christopher, 1985:1.147).

Methods of Measuring Productivity. There are several methods that can be used to measure productivity. These methods are divided into two major categories. These categories are static productivity ratios and dynamic productivity indexes.

Static productivity ratios are ratios of outputs to inputs at a particular point in time. These ratios provide a "snapshot" measure of productivity at that point in time. A static productivity ratio doesn't show any relationship to the productivity of previous periods and therefore, can't be used by itself to spot productivity trends (Issues in White Collar Productivity, 1984:9).

A dynamic productivity index is a measure of the ratio between the static productivity ratio for one period and the static productivity ratio for another period. In other words, it is the ratio of the static "snapshots" for two different periods. Therefore, at least two static productivity ratios are determined and then used to develop the dynamic productivity index. This index provides a measure of how productivity has changed (increased or decreased) between the two periods. Because the dynamic productivity index can be used to look for productivity trends, this is the type of productivity index used in this thesis.

Within these two categories, there are three basic types of productivity measures. These types are the total factor productivity measure, the multi-factor productivity measure, and the partial factor productivity measure.

If all of the outputs and all of the inputs for a given organization are included in the measure of productivity, then that measure is called a total factor productivity measure (Issues in White Collar Productivity, 1984:9). In practice, a total factor productivity measure can be hard to develop if the organization is large. First, identifying all of the inputs and outputs can be very difficult. Second, many of these inputs and outputs may be very hard to quantify.

A multi-factor productivity measure is a measure that includes some or all of the organizational outputs, but only some of the inputs (Issues in White Collar Productivity, 1984:9-10). Even though this measure doesn't include all of the inputs, it may still be hard to identify and quantify the inputs and outputs it does include.

A partial factor productivity measure includes some or all of the outputs and only one type of input (Issues in White Collar Productivity, 1984:10). While this measure avoids the problem of trying to identify and quantify most or all of the inputs and outputs, it can result in misinterpretation of productivity figures. For example, if the wrong input is used, a manager could relate a low productivity figure to the wrong factor.

Two partial factor productivity measures have been applied successfully in professional, administrative, and service organizations (Christopher, 1985:3.3). These measures are the Administrative Productivity Indicator (API), including the Hours per Unit (HPU) productivity measure (an adaptation of the API), and the Multiple Output Productivity Measure.

Administrative Productivity Indicator (Christopher, 1985:3.3). The API is defined as the unit of work output divided by the number of labor hours input. Within the API, the unit of work output is defined as the physical, measurable, or countable thing which describes what the organization does in achieving what it was organized to do.

$$API = \frac{Units\ of\ Work\ Output}{Person\ Hours\ Input}$$

The API method most closely approximates the methods used to measure productivity in plants and can be used where a single output can be defined as the measure

of the successful performance of the process. According to Christopher, there are four steps to creating an API. These steps are:

(1) State the key purpose for the unit.

(2) Identify the physical output which determines how successfully the unit has achieved its purpose. This output can be defined as a physical product or service that has been created or processed.

(3) Test the selected work output to ensure completion of the work assures the purpose is achieved.

(4) Define the input measure. For most administrative units the predominant input is person hours of work.

For administrative and service organizations, the use of materials, energy, and capital aren't important factors for measuring productivity. For this reason, the best productivity measures for these types of organizations are usually expressed in terms of work output in relation to person hours of work.

Hours per Unit of Work. A better, more typical measure of productivity for administrative and service organizations is the hours per unit of work (HPU). Service personnel tend to work on several projects at the same time with each project at a different stage of completion instead of working on one project at a time until completion. Therefore, most organizations better understand a measurement of the number of hours spent to accomplish one unit of work (the HPU measure). The HPU productivity measure is calculated by inverting the API (Christopher, 1985:3.4).

$$HPU = \frac{Person\ Hours\ Input}{Units\ of\ Work\ Output}$$

The organization would then attempt to reduce the HPU required to complete a specified process. The HPU measure is also typically used to identify and analyze productivity trends.

For administrative and service organizations, the four steps to creating the API (and therefore the HPU) may seem difficult. However, if the collective work of the organization is broken down into a series of processes (with each process accomplishing one piece of the collective work), it is easier to accomplish each step for that process because it is easier to identify the end product and the amount of time spent completing the process. By measuring the productivity of each process, you can see exactly where the organization has productivity problems.

Multiple Output Productivity Measure (Christopher, 1985:3.5 - 3.8). In some administrative and service organizations, a single output measure is not considered adequate. The use of several outputs is required to adequately represent the successful completion of the organization's objective. These outputs are combined into a single, overall organizational measure known as a multiple output productivity measure. The procedure for the multiple output productivity measure is as follows:

(1) Define the purpose of the organization.

(2) Test the definition of the purpose by relating it to the purpose and objectives of the next higher level of the organization.

(3) Identify the outputs which represent the successful achievement of purpose.

(4) Determine how to measure each of the outputs.

(5) Calculate measures for each output for a base period.

(6) Establish a rating scale and place the base measurements in the middle so both increasing and decreasing trends can be measured.

(7) Prepare a rating form for each output showing the base measurements.

(8) Determine weights for each output and combine all the outputs into one.

(9) Identify inputs and measures for them.

(10) Measure inputs, single outputs, and the combined output. Monitor for trends.

The biggest difficulty with the Multiple Output Productivity Measure is the step involving the combination of outputs into one overall output. However, with some careful thought and analysis, this step can be accomplished.

The Multiple Output Productivity Measure is a good indicator of overall productivity for organizations with several outputs. In addition, this measure provides a good method for measuring productivity trends.

Other Factors that Affect Productivity. External influences on productivity could cause the productivity measurements of a newly implemented information system to be lower than estimated. Managers not aware of these external influences may overreact and expend resources correcting an information system that isn't broken. These detrimental actions are avoidable if managers are mindful of the other factors that affect productivity. Conversely, the productivity increase of a new information system could actually result from external factors and not the information system. In this case, managers might not discover system problems until the problem becomes serious. Whenever the complex input and output productivity relationship of a process is tested by using a simplified formula, the effects of external factors are possible. Some of the other factors that

influence productivity are: lack of training, changes in the manager's attitude, resistance to change, environmental changes, and changes to an employee.

Training. When implementing an information system, the initial level of productivity increase and the rate at which productivity increases are greatly affected by training (Ruprecht and Wagoner, 1984:461-462). Without proper training, employees are slower to learn the new system. While interviewing employees at AFIT/RRE on work processes, a few of them expressed a concern that they wouldn't receive the needed training for a new system. In addition, a lack of knowledge about a new information system can magnify problems and cause extended delays as employees try to solve their own problems. Blindly attempting to fix one's own problem causes a reduction in productivity. Also, a lack of understanding about a new system can lead to anxiety and fear of the new system. A timely and complete training program helps to reduce the negative effects a new system has on productivity (Ruprecht and Wagoner, 1984:461).

Managers Attitude. Managers' and supervisors' attitudes and actions have a direct influence on subordinates (Lawlor, 1985:123). Problems with a new system can cause a manager to develop a negative attitude concerning the system; this negative attitude can grow among the employees. Managers need to guard against displaying any negative attitudes. Employees should be shielded from negative premature findings and unsubstantiated problems with a new system.

Resistance to Change. Many employees don't like change. When confronted with change, these workers resist and try to keep the change from occurring (Mundel, 1983:19). This resistance is part of the employees psychological essence. For

these workers managers need to provide facts and information well before the change occurs. If there is a valid reason, open communication with the employee may help expose the reason for resistance. Providing training before implementing the new system can facilitate an employees acceptance of the change (Ruprecht and Wagoner, 1984:462).

Work Environment. Care must be taken to ensure the work environment is kept stable or improved as part of the implementation. Changes to lighting conditions, air temperature, ease of movement, and so on are possible when implementing a new system. When equipment is added to an office, care is needed to ensure that the employee is comfortable and that the new layout is conducive to productivity.

Employee Changes. Some personal events can have an impact on an employee's work performance. If productivity measurements indicate a reduction in processes accomplished by a single employee then personal factors could be the cause. Managers should monitor the employee for performance that isn't typical of the employee. If appropriate, the supervisor should determine whether the employee is aware of the performance reduction. Other actions by the supervisor depend on the situation and organizational policies. Some employee changes that reduce productivity are seasonal, such as the flu season, and are not within the manager's control.

After an appropriate learning period, managers should investigate productivity measures that don't increase as expected. Unfavorable productivity measures can result from these external factors and not from the information system itself. Once the cause is identified, managers should implement corrective actions and remeasure productivity.

Documenting Work Processes

Flow charting is a useful tool for describing many concepts such as an algorithm, computer program, or procedure. These concepts are typically described by a series of instructions or tasks for accomplishing an objective. Most often, a graphical flow chart representation of the tasks is easier to grasp and understand than a written word representation (Schriber, 1980). In this thesis, flow charts are used to describe the work processes of AFIT/RRE and form the basis for measuring productivity. To simplify development and improve communication of representations, a standard set of symbols is used in flow charting.

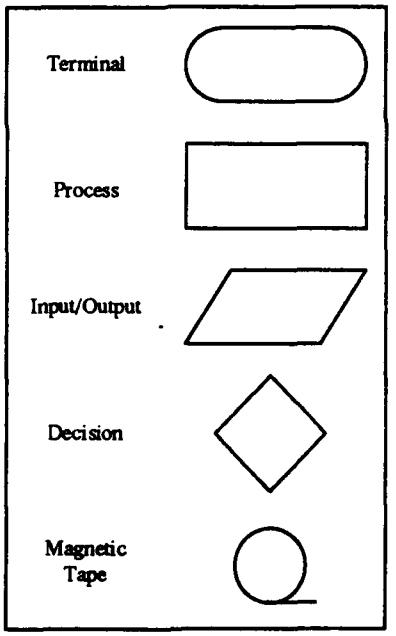


Figure 2-1. Symbols used for flow charting

Mario Farina describes in his book, Flowcharting, the symbol set used by this thesis team to develop the AFIT/RRE work processes (Farina, 1970). Even though his book is written for a student in computer programming, the symbology convention is

applicable for any description that is formed from a series of tasks to complete an objective. Figure 2-1 shows the symbols relevant to this thesis. The first symbol is called the terminal symbol and is used to show where a procedure begins and where it ends. The next symbol is the process symbol which represents a processing function, such as a calculation. The third symbol is the input/output symbol. This symbol is used where there is an input or an output to the process. The decision symbol is used to show possible alternative courses of action. The test or decision is defined within the diamond. Possible actions are represented by arrows projecting from the diamond. In flow charting, arrows indicate the sequence or flow that the process is to follow. The fifth symbol is the magnetic tape symbol and is used to represent input from or output to a electronic storage media. In the past, magnetic tape was used for nearly all electronic storage. Even though today magnetic disks, optical disks, and other media are available for storage, the magnetic tape symbol is still used.

Paperless Techniques

Most standard techniques used in information systems are directly applicable to developing a paperless information system. In an office automation experiment conducted at Rome Air Development Center (RADC) the averaged results indicate that time savings were 2 percent for managers, 27 percent for professionals, and 55 percent for administrative support staff (Warren, 1986:17). Ruprecht and Wagoner report that experts at industry conferences suggest typical office automation productivity improvements of 10 to 15 percent for management, 20 to 30 percent for secretarial, and 35 to 40 percent for clerical (Ruprecht and Wagoner, 1984:282). All of the groups

require word processing, but to different degrees. The benefits of a paperless information system come from improved management of workers, easier access to information, quicker communications, better organization of work, and so on. In the Ruprecht and Wagoner study, a higher percent productivity increase for management is reported due to paperless information systems allowing management to delegate more work to employees (Ruprecht and Wagoner, 1984:238-240). For professionals, they receive the same benefits as management plus the benefits of improved administrative tasks. A professional performs tasks that are derived from the tasks of other groups, such as creating reports and presentations, research, project monitoring, and other similar tasks. At RADC, secretarial and clerical tasks are combined into the administrative category. Secretarial tasks are answering the telephone, taking messages, proofing, scheduling, copying, some distribution, and other similar functions. The clerical tasks are primarily records management, data entry, distribution and other similar tasks. Specific techniques are discussed below.

Automated Forms. An employee selects the appropriate form from a menu. The form is displayed on a screen. Depending on the function being performed, the employee fills in the form by selecting a command or typing in the needed information. This improves productivity by: eliminating the time obtaining a form, reducing the time filling out a form (a significant portion of the form, if not all, is automatically filled in from the database), and eliminating the time to distribute the form. Distribution of the form is accomplished automatically by Electronic Mail (E-mail) or is routed to a queue for a

clerical person to accomplish. In addition, information is recorded as to which forms are distributed.

Automated Standard Documents. This technique is similar to using a form letter, but with easier access, completion, and distribution. A database of standard documents is maintained on line. If an employee is performing a particular function at the time a document is requested, the document is automatically filled in with information such as name, social security number, previous education or work experience. Additionally, any missing data needed to complete the document and any other data appropriate for the function are indicated. As discussed above, this improves productivity by: eliminating the time creating the text of a document, reducing the time collecting the data or facts for the document, and eliminating the time to distribute the document.

Automated File Access. An employee requests the appropriate file from a menu. The file is available within seconds. A list of the file's contents should be included with the file. This improves the productivity of the employee tremendously by eliminating the time to retrieve a file or waiting for someone else to retrieve the file. The employee can complete a task while the details are still fresh in their mind. With a listing of the file contents there is no searching through the file to find the information. An employee selects the subject of interest from the list and that data is displayed. In addition, the file is not lost, not misplaced, is available to others at the same time, and is refiled immediately after use.

E-mail. This is the transfer of an item that is in electronic form from one point to another. This is from person-to-person or system-to-system or various combinations of

these. With a paperless information system nearly all correspondence (documents, forms, and similar paper type products) and communication (paper or phone notes and messages) are accomplished by E-mail. Productivity is improved by using an automated address book to address and distribute the mail which saves employee time. Outgoing and incoming mail requires less handling and is better organized reducing the time required of employees.

Process Control. In a paperless information system data is collected on the work distributed for processing, work in progress, work completed, and other data required by management or coworkers. A study is conducted before developing a paperless information system to collect and distribute the correct data. The discipline of Information Engineering provides a methodology for accomplishing this critical study. In large organizations a significant amount of time is expended to gather and present the needed data. Automating the gathering and presentation of the data increases productivity by reducing the amount of time employees spend on this task.

Similar Applications

Companies are using the previously identified techniques and others to develop paperless information systems. A discussion of these companies serves to confirm the usefulness of the techniques and provides data on the possible extent of the productivity increase.

The United Services Automobile Association. Not only is the United Services Automobile Association (USAA) a leader in the effort to operate paperless, but the functions performed by this paperless information system are similar to those at AFIT/RR.

Several personnel from AFIT/RR traveled to USAA headquarters to observe the company's paperless operations. The decision to pursue a paperless system at AFIT/RR was influenced by the USAA's achievements and success. In the early 1980s, USAA developed a long range strategic plan to evolve a paperless information system. The first major step was development of a computerized Management Information System (MIS). This system is composed of a database of customers and related insurance actions. In 1984 and 1986 the company implemented two prototype imaging systems for the conversion of paper documents into electronic documents. In 1987, the USAA selected IBM to develop the permanent imaging system. Employees rate the system as easy to use and the company is pleased with how well the MIS and imaging system are integrated (Leinfuss, 1990:77-82). An interesting note is that according to one source, the direct savings from eliminating paper (handling, storage, and so on) can be estimated with reasonable confidence prior to implementation of the projec· However, the productivity benefits, which are usually significant and important to the justification of the system, cannot be projected accurately prior to the installation of the system (Plesums and Bartels, 1990:344-345).

The USAA uses several techniques in their paperless information system. These techniques are discussed below.

a) USAA indexes the records first and then scans the document into the system. An index describes the contents of each record such as important dates, form numbers, actions needed, and so on. The actual indexing is performed wherever the mail is first read to identify the customer, determine the routing, and retrieve all the appropriate

information. In addition, indexing before scanning helps to ensure all the relevant documentation is collected before the paper copies are destroyed. It also links routing and processing instructions to new records.

b) To facilitate tracking, the work is performed in batches. Typically these batches are kept small to control and monitor the process. In an automated system, statistics are gathered on the work progress. A manager can review the statistics and make appropriate adjustments. Stacks of paper are replaced by a number that represents the quantity of files in a particular queue. Supervisors also use the system to assign work to their employees. Priorities are set for each piece of work so that important work is not lost in the pile.

c) USAA tried using two monitors to display the document image and the data screen. Employees found it better to have two screens on one monitor. USAA found that it increased productivity to maintain a list of file contents with the file. The list is read quicker than reading the entire file. In 24 percent of the cases in the first application at USAA, the users satisfied their inquiry without reference to any documents. Simply knowing whether a document was (or was not) in the file, based on the table of contents was sufficient.

d) Access to a paper file typically took long enough that, if file information was necessary during a phone call, users preferred to call the customer back. A significant productivity gain could be achieved if the customer could be served during the initial phone call.

The USAA has achieved many different benefits from their paperless information system. Several of these benefits are discussed below.

a) When the research project began in 1982, 196 people were dedicated to delivering the mail and maintaining the 1.3 million files. By 1987, as full-scale implementation took place, only 161 people were needed to maintain 1.7 million files. By 1990, about 40 personnel were needed to maintain approximately 2.0 million files. This is just over a 60 percent reduction in the workforce and over 50 percent increase in files to maintain. Similar to AFIT/RR today, USAA originally stored active documents in paper folders.

b) Support costs are reduced by the savings in clerical staff, office (file) space, warehouse space, equipment, and supplies. These direct savings can be estimated with reasonable confidence prior to implementation of the project.

c) The productivity of the professionals using the system is improved through immediate access to the files necessary to serve a customer, as well as better management and control of the work in process. Paper intensive shops often claim 30 percent or more productivity improvement. These benefits are very large and important to the justification of the system, but cannot be projected accurately prior to the installation of the system. At USAA, 85 percent of the work is received by phone rather than by mail. Improving access to files through an image system increased the productivity of the 2000 professionals at USAA an estimated 2 to 10 percent.

d) Customer Service is improved by the immediate, simultaneous access to files. These savings are intangible, but important.

e) Document and file security is improved since papers are not removed; there are no missing files or misfiled documents. An on line audit trail records all accesses and

changes to the files. These benefits are also intangible, but are valuable even though it is difficult to assign a cash value.

Cigna Insurance. Another company that implemented a paperless information system and that performs tasks similar to those of AFIT/RRE is Cigna Insurance. Cigna analyzed total system requirements and developed a plan before making any changes. Their solution uses electronic forms and electronic mail (E-mail). The changes were completed in three phases: automate the filling out and printing of forms, automate the transfer of forms using E-mail, and tie the forms processing directly into the MIS. A key factor of Cigna's success is that each form is reengineered based on its planned use. An important note is that the electronic form did not have to look like the printed paper version. Actually, employees state it is usually more efficient to optimize the electronic form for the computer screen. To make data entry easier, data fields on the electronic form should incorporate error detection. The company reports that they have reduced forms processing time and saved millions of dollars in printing, storage, shipping and postage, and waste removal costs (Smith and Eglowstein, 1993:67-76).

Summary

To determine the nature and extent to which paperless information infrastructures can increase productivity in the Registrar Directorate, we have to understand what functions the Directorate performs. This chapter discusses those functions.

Typically, productivity is difficult to address in administrative and service organizations. Some of this difficulty stems from several definitions of productivity, limitations of productivity measures, and other difficulties in measuring productivity. This

chapters provides information necessary to define and measure productivity in administrative and service organizations. Research of productivity literature indicates that the eight steps identified by Christopher are useful for developing a productivity measurement plan. To accomplish the sixth step (developing a productivity measure), the partial factor productivity measure is possibly effective if the organization is subdivided into processes and the inputs to each process are used to measure the productivity of that process. The Hours Per Unit of Work productivity measure is the most appropriate for the processes of most administrative and service organizations.

The study of paperless techniques and similar applications is also critical to this thesis effort. This chapter provides the results of research into these areas. There are numerous lessons learned and time saved by researching other's attempts, successes, and failures.

Conclusion

The combination of all of the research in this chapter leads to the conclusion that the Evaluations and Admissions Division (AFIT/RRE) is an appropriate choice for this thesis because of the nature of its processes (presented in chapter four) and the availability of information. In addition, for the reasons given in this chapter, the DOD definitions of productivity and the Hours per Unit productivity measure are the most appropriate for the measurement of productivity in AFIT/RRE. The methodology for using this definition and productivity measure is presented in chapter three.

III. Methodology

Overview

As stated in chapter one, the research objective is to determine the nature and extent to which a paperless information infrastructure affects the productivity of the Air Force Institute of Technology Evaluations and Admissions Division (AFIT/RRE). To solve this problem, five investigative objectives were identified. The first objective is to define productivity and develop measures of productivity as they relate to AFIT/RRE. The second objective is to define the processes used by AFIT/RRE to accomplish their mission, determine whether a subset or all of the processes must be measured, and finally measure the productivity of the selected processes. Next, we applied paperless techniques to the current work processes to develop a representative paperless information system model. The fourth objective is to remeasure the productivity of the selected processes. The final objective is to compare and contrast the two sets of measurements. The product from accomplishing these objectives is determination of the nature (primarily from the identified paperless techniques) and extent (from comparing the measures of productivity) to which a paperless information infrastructure might increase the productivity of the AFIT/RRE. This chapter defines the methodology used to realize these objectives.

Explanation of Research Design

Objective One. Most of the data needed to define productivity and develop measures of productivity are acquired and documented in Chapter Two. Definitions and measures of productivity are developed from a thorough review of periodicals, other

research, and reference books before progressing to Objective Two. From this research, a definition and measure of productivity is selected.

Objective Two. To complete this objective, we first determine the mission of AFIT/RRE. An operational definition of AFIT/RRE's mission statement is provided in Chapter Two. The mission is then decomposed further by identifying the process (steps and actions) that AFIT/RRE personnel use to accomplish their mission. This information is obtained by reviewing regulations, operating instructions, records, and other documentation and by interviewing AFIT/RRE personnel. From reviewing the various documentation, a draft set of process flow charts is developed. These flow charts are drawn using standard flow charting conventions and symbols as described in Flowcharting by Mario Farina. During the operation of collecting data, the process flow charts mature through the continuous cycle of chart updating and then AFIT/RRE review. Although the charts can be updated at anytime, Objective Three is started when AFIT/RRE and this thesis team concluded that the charts are sufficiently complete in representing all the mission processes.

Since most of the processes have similar steps and the time allowed to complete this research is limited, only a subset of the processes are used to complete the fourth objective (the fourth objective applies paperless techniques to the processes and then remeasured the productivity). To determine which processes to include in this subset, a Pareto analysis is performed. The basic steps used in the Pareto analysis were 1) the processes are listed in descending order of average number of yearly hours, 2) the percent

of the total average yearly hours are calculated, 3) the top processes representing 80% of the total average yearly hours are selected (Lawlor, 1985:165).

Objective Three. Information from the literature review on paperless techniques and similar applications and data from the second objective are used to develop a representative paperless information system model for AFIT/RRE. The modeled paperless information system consists of a collection of flow charts, process connections and productivity relationships. These process flow charts represent proposed AFIT/RRE paperless processes. These proposed AFIT/RRE paperless processes are generated by applying appropriate paperless techniques to the current AFIT/RRE processes. The candidate techniques are described in chapter two. Obviously, only techniques that demonstrate a potential for time savings are applied. The supporting evidence for these time savings is found in chapter two.

Objective Four. We use the processes identified in the second objective and the paperless information system model developed in the third objective to complete this objective. The fourth objective is the most difficult to define. Typical tests of productivity take measurements using the original processes and then take measurements using a prototype system that incorporates the variable of concern. Then comparisons of the two are made resulting in data to support or overturn the hypothesis. Our difficulty is that there is no prototype system or simulation model available to develop data for comparison. Discussions with professional computer consultants from several companies turned up no standards for developing or measuring time savings. To overcome this obstacle we substituted reasonable estimates of time savings into the AFIT/RRE paperless

processes developed in objective three. These estimates are based on the authors' expert judgment.

Objective Five. The final objective requires that the productivity data of AFIT/RRE's current processes be compared and contrasted with the estimated productivity under the paperless information system model. This is accomplished by calculating the percentage change in required time. The details of this analysis are included in chapter four.

Methods of Data Collection

There are two methods involved in achieving the investigative objectives. These methodologies are non-behavioral observation and interviews. Non-behavioral observation includes reviewing various documentation and visiting AFIT/RRE to observe the division's functions and operations. For interviews, a two person team conducts the interviews to increase the reliability in documenting the responses. Generally, unstructured interviewing techniques are used. However, the process flow charts are used to guide the discussions.

Measuring Productivity of Work Processes

Measuring productivity of the processes is completed by using the Hours per Unit (HPU) productivity measure discussed in Chapter Two. The average number of yearly hours is calculated by using a weighted average. To calculate each process weighted average, the average yearly inputs are multiplied by the time required to complete each step. On steps where percentages are given, the number of inputs are multiplied by the

percentage and then that number of inputs is multiplied by the time required for each step in that branch of the process. After all the inputs are flowed through the appropriate steps, the total number of hours is input into the HPU formula (along with the number of inputs) to calculate the HPU productivity measure.

The following is an example of how these calculations are performed. The process shown in Figure 3-1 has six steps and has an average input of 100 per year. This means this process is performed, on average, 100 times per year. The first step is typically the receipt of a request for some action of information. This request begins the process. The

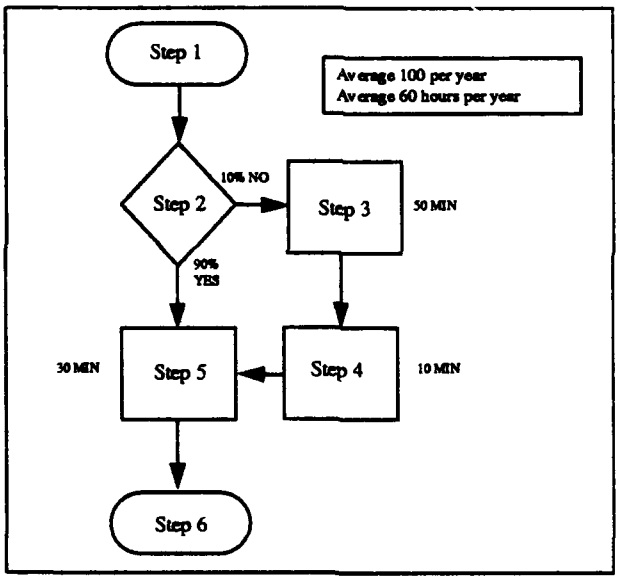


Figure 3-1. Example Process

second step indicates a decision must be made based on information in the request. These first two steps have taken no time since the process starts with the receipt of the request and the decision is automatic. At the decision point, 10 percent of the inputs go to step 3 and 90 percent go to step 5. The 10 inputs that go to step 3 take 50 minutes at step 3 and then go to step 4 to take an additional 10 minutes. These inputs have spent 60 minutes in the process at the point of completing step 4. Therefore, a total of 600 minutes (60

minutes per input times 10 inputs) is required to reach this point. These 10 inputs now go to step 5. The 90 "Yes" inputs also proceed to step 5 without taking any time in the process. At step 5, all 100 inputs (10 from step 4 and 90 from step 2) spend 30 minutes. This adds another 3000 minutes (30 minutes per input times 100 inputs) to the required time. From step 5, the inputs go to step 6 ending the process. At this point, a total of 3600 minutes are spent on this process. Dividing by 60 to convert to hours, an average of 60 hours per year is spent performing this process.

After the processes are transformed into paperless processes, the same number of inputs are used to recalculate the average number of yearly hours and the HPU productivity measure. Then the two HPU measures are compared.

Application of Paperless Techniques

The processes that represent over 80% of the total average yearly hours spent are selected for transformation. Each of these selected processes is transformed into a process that accomplishes the same task, but as part of a paperless information system.

The transformation of the selected processes is done by applying the paperless techniques discussed in Chapter Two to each process. To perform this transformation, each process is broken down into its individual steps (shown as blocks in the process). Each step is then analyzed to see if the process can be performed differently in a paperless information system. This analysis is done by using the knowledge and experiences of the authors to determine the best way to complete the step in a paperless information system (using current technology). If the process changes under a paperless information system, an estimate of the time savings is made.

Discussions with computer consultants from several companies and an extensive research of literature resulted in no standard means to estimate time savings under paperless information systems. Therefore, the estimates of time savings used in this research come from the personal experiences of the researchers. Combined, Capt Bihary and Capt Shrader have over 20 years of experience in maintaining, operating, networking, and supporting computers in an office environment. Some standard time savings are used. For example, the time to prepare a letter is reduced by two thirds. This reduction comes from the use of standard or form letters that the computer completes automatically using information in the records. The time to evaluate a record, compare it to guidelines, and annotate a decision is reduced by one half because the computer displays the appropriate guidelines and indicates where the record falls within those guidelines to the evaluator. This makes the evaluation easier. Some steps are completely eliminated. The steps required to request, retrieve, and file records are no longer necessary under the paperless information system because the records are kept on the computer system. Similarly, the time required for the transferring of records and letters between personnel is reduced by the use of E-mail. For other steps, best estimates are made.

The results of these process transformations are new processes which represent a paperless information system. The average yearly hours and the Hours per Unit productivity measure of these process is then recalculated.

Conclusion

The methodology to complete the research objectives presented in this chapter encompasses the steps needed to solve the thesis purpose. As stated above, a variety of

information is needed to complete these objectives. Most of the information required comes from a review of documentation and interviews of AFIT/RRE personnel. This information is then analyzed and documented to complete the objectives. The completion of these objectives completes the thesis purpose.

IV. Data Description and Analysis

Introduction

This chapter presents the data gathered from the methodology described in Chapter Three and the analysis of that data. First, the work processes of the Admissions and Evaluations Division (AFIT/RRE) of the Air Force Institute of Technology's Registrar Directorate are identified. Then, the average number of times each process is accomplished in a year are calculated or estimated. Third, the average number of hours required to perform each process and the Hours per Unit (HPU) productivity measure for each process is calculated. Next, the processes that account for 80% of the hours are identified. Fifth, the selected processes are transformed by applying the paperless techniques identified in Chapter Two. Next, the estimated average number of hours spent on the each transformed process is calculated using the same number of inputs. Then, the HPUs for the transformed processes are calculated. Finally, the HPUs for the original processes and the same transformed processes are compared.

Work Processes of AFIT/RRE

As stated in Chapter Two, the mission of the Admissions and Evaluations Division is to manage the procedure for admitting students to the appropriate AFIT program. The accomplishment of this mission involves several functions (see Chapter Two for the complete list). The measurement of productivity using the Hours per Unit of Work method is easier when the functions of the organization are broken down into measurable processes with identifiable inputs and outputs.

The processes that AFIT/RRE uses to accomplish its mission are identified through research of operating instructions, Air Force Directives, and manpower studies, and (most importantly) interviews with Division personnel. Seventeen processes are identified and documented. The processes are documented by developing flowcharts that show the steps in the process and the time required to complete each step. These flowcharts are presented in the appendix to this thesis.

Work Process Calculations

Review of AFIT/RRE monthly work summary sheets and interviews with AFIT/RRE personnel provides the average number of times a process is performed in a year. Some of these values are documented in monthly counts that are used to calculate the yearly average and other values are estimates made by AFIT/RRE personnel. The calculated numbers are shown in Table 4-1 and the estimated numbers are shown in Table 4-2. Using these numbers, the number of average yearly hours spent doing the processes is calculated. These calculated average yearly hours and the average yearly outputs from Tables 4-1 and 4-2 are then used to calculate the HPU for each process. The results from these calculations are shown in Table 4-3.

Table 4-1. Calculated Average Yearly Number of Times Process is Completed

Process / Month	Program Eligibility Determination	ROTC Technical Curriculum Reviews	MPC Evaluations	Perform Central Identification on Line Officers	Process Medical Program Waiver Request	ROTC Board Evaluations
Oct-92	290	25				7
Nov-92	260	101				0
Dec-92	319	70				6
Jan-93	255	72				0
Feb-93	212	98				0
Mar-93	466	422				0
Apr-93	273	4				0
May-93	259	16				0
Jun-93	218	30				10
Jul-93	297	25				0
Aug-93	350	13				0
Sep-93	325	19				126
Oct-93	194	6		237		39
Nov-93	227	15		41		6
Dec-93	182	2		11		3
Jan-94	239	22		0		1
Feb-94	369	7	42	267	25	2
Mar-94	256	25	17	100	22	4
Apr-94	281	35	6	100	10	3
May-94	209	3	6	200	10	6
Monthly Average	274	51	18	120	17	11
Yearly Average	3289	606	213	1434	201	128

Table 4-2. Estimated Average Yearly Number of Times Processes Completed

Process	Yearly Average
Program Selection	1000
Generate Selection Reports	52
AFSC Determination	240
ROTC/AFIT Direct Accession	10
PhD Program Support	33
Academic Code Determination	416
Local AFIT Program Eligibility ROTC Briefing	12
AFIT Education Newsletter	1
Program Fact Sheets (For Part Time Students)	4
Change Academic Eligibility Information	520
Special Program Evaluations	420

Table 4-3. Calculation of Average Yearly Hours and HPU

Process	Average Yearly Hours	% of Total Average Yearly Hours	Average Yearly Output	HPU
Program Eligibility Determination	7265.40	44.47%	3289	2.21
Program Selection	3109.53	19.03%	1000	3.11
PhD Program Support	1455.71	8.91%	33	44.11
MPC Evaluations	1302.85	7.97%	213	6.12
Generate Selection Reports	773.76	4.74%	52	14.88
Change Academic Eligibility Information	576.60	3.53%	520	1.11
ROTC Technical Curriculum Reviews	466.92	2.86%	606	0.77
Academic Code Determination	424.32	2.60%	462	0.92
ROTC/AFIT Direct Accession	158.87	0.97%	10	15.89
AFSC Determination	149.00	0.91%	240	0.62
AFIT Education Newsletter	105.08	0.64%	1	105.08
Process Medical Program Waiver Request	63.38	0.39%	201	0.32
Program Fact Sheets (For Part Time Students)	50.33	0.31%	4	12.58
Local AFIT Program Eligibility ROTC Briefing	30.00	0.18%	12	2.50
Perform Central Identification on Line Officers	27.92	0.17%	1434	0.02
ROTC Board Evaluations	68.27	0.42%	128	0.53
Special Program Evaluations	309.96	1.90%	420	0.74
TOTAL	**16337.90**	**100%**	**8625**	**1.89**

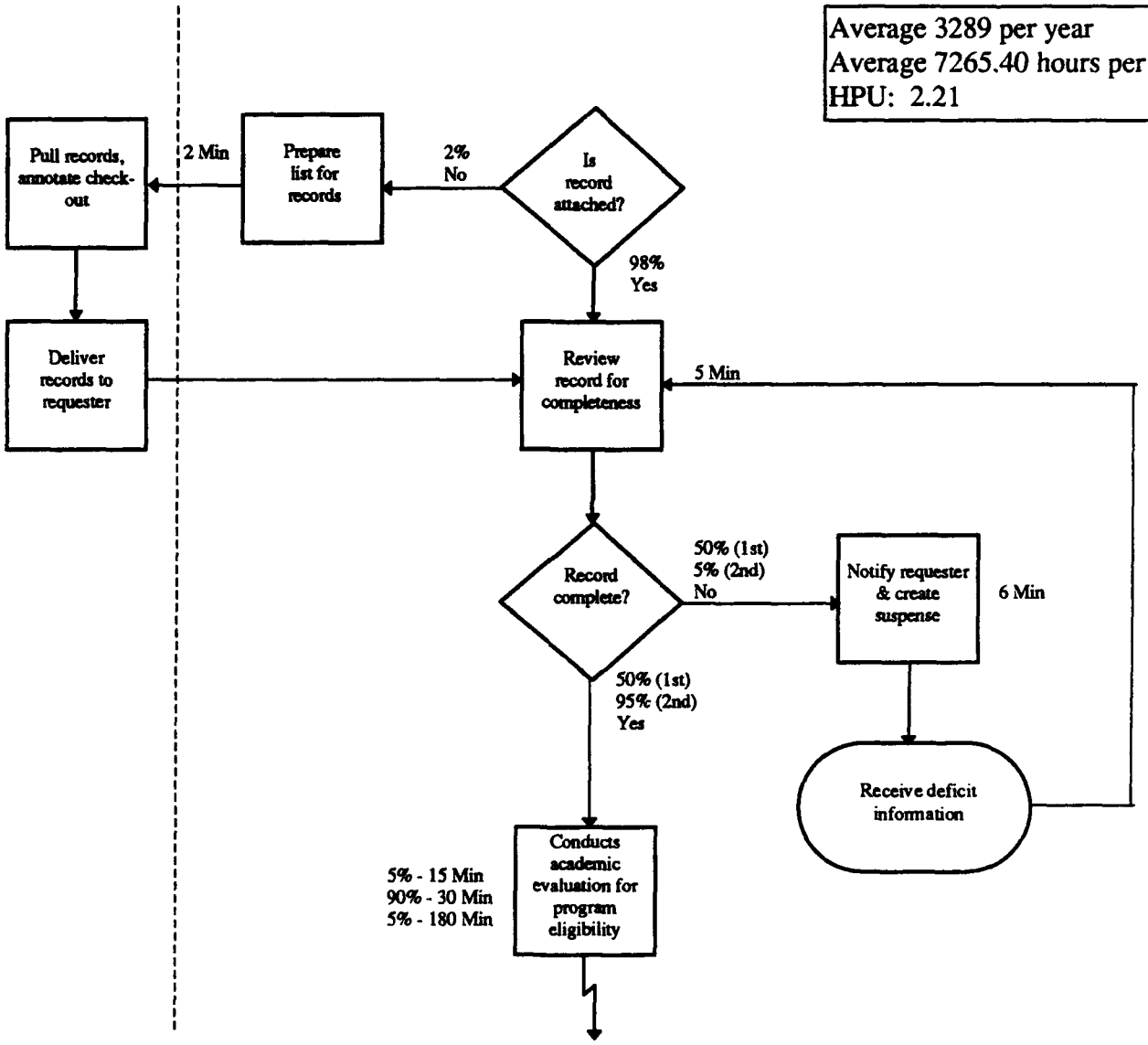
Work Process Selection

The processes in Table 4-3 are sorted in decending order based on the average yearly hours spent on each work process. Using a Pareto analysis on the data in this table shows that the top four processes are responsible for 80.38% of the total average yearly hours spent. These four processes are described in flow chart form in Figure 4-1, Program Eligibility Determination, Figure 4-2, Program Selection, Figure 4-3, PhD Program Support, and Figure 4-4, MPC Evaluations.

Work Process Descriptions and Transformations

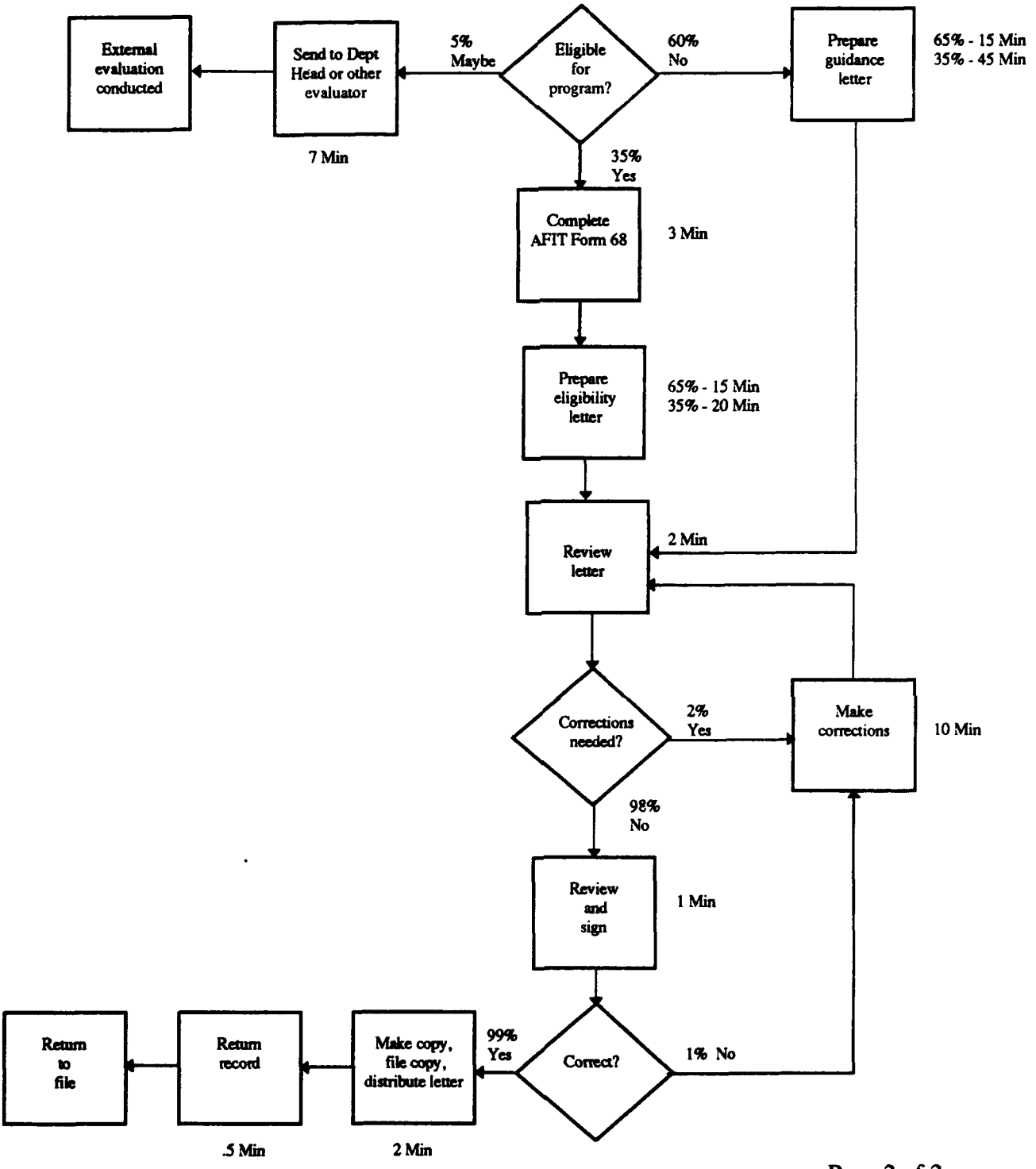
The four processes identified in Figures 4-1 through 4-4 have some common steps. These include requesting records, evaluating records, preparing letters, and filing documents. After the application of the paperless techniques discussed in Chapter Two and based on the discussions of those techniques in Chapter Three, the amount of time required to perform each of these steps under the paperless information system showed significant reductions.

The requesting of records is eliminated since all records are accessible at the worker's computer and automatically loaded when required. The evaluation of records is easier under the paperless information system because the records are screened by automated guidelines for the evaluation. The computer would immediately indicate to the evaluator where the record fits within those guidelines therefore greatly reducing the amount of time required. On average, this reduces the time required by one half. The



Page 1 of 2

Figure 4-1. Program Eligibility Determination



Page 2 of 2

Figure 4-1. Program Eligibility Determination (cont)

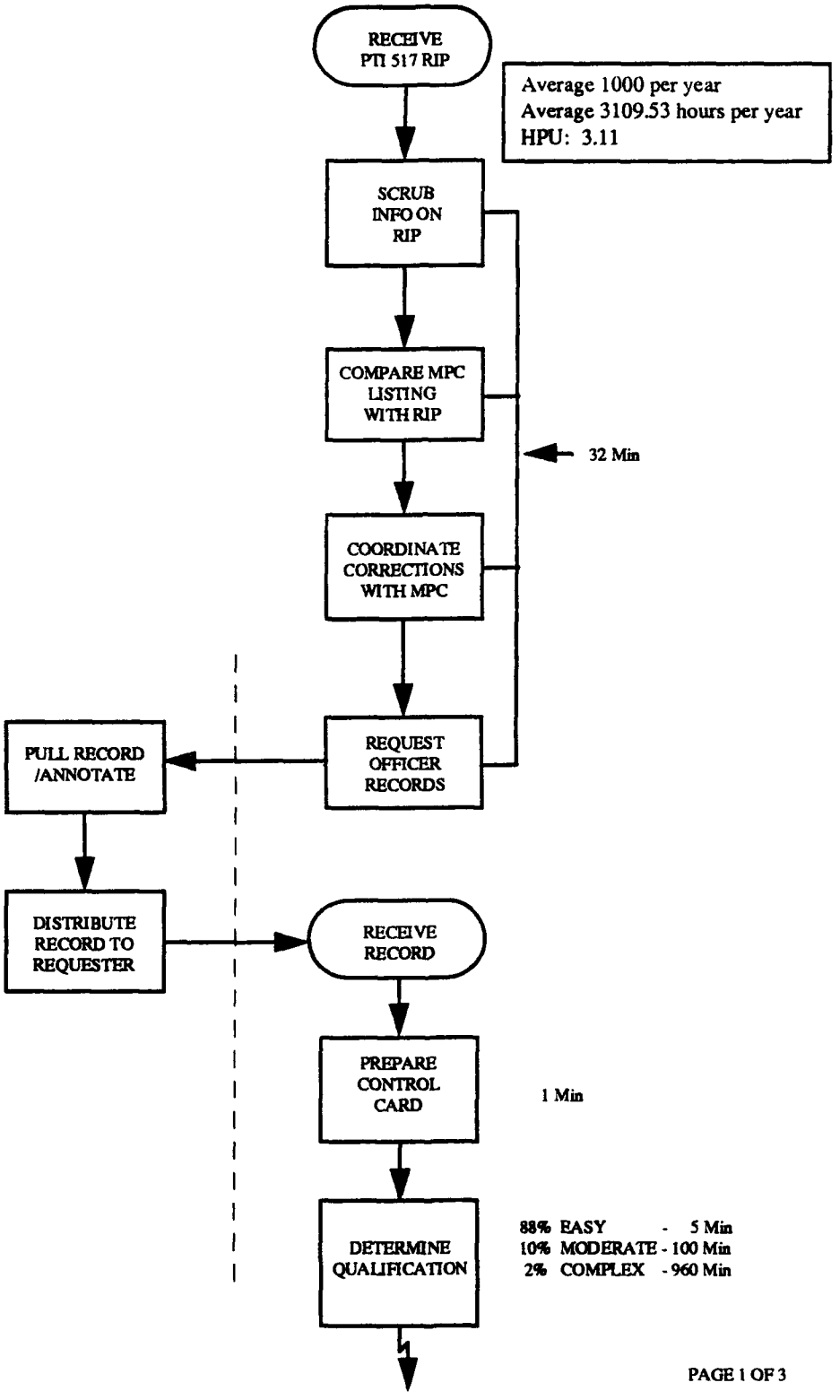


Figure 4-2. Program Selection

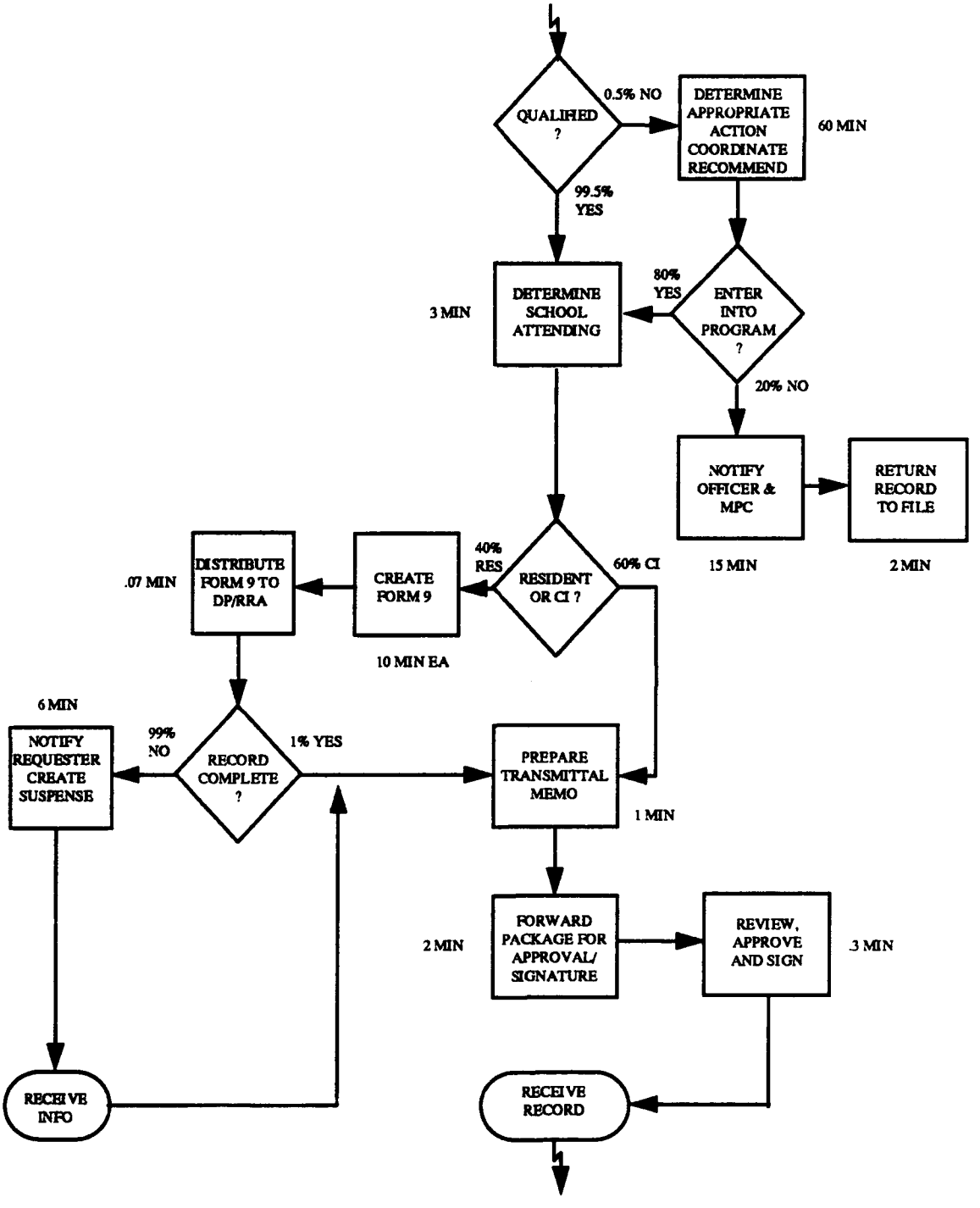


Figure 4-2. Program Selection (cont)

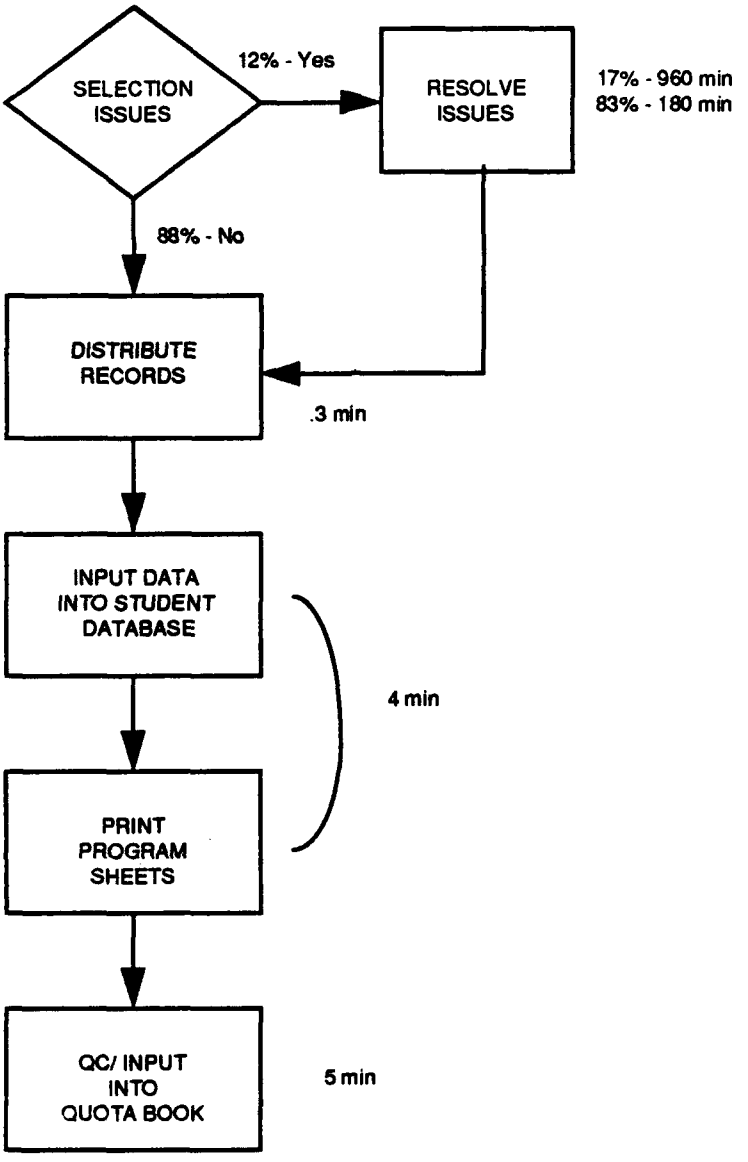


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Figure 4-2. Program Selection (cont)

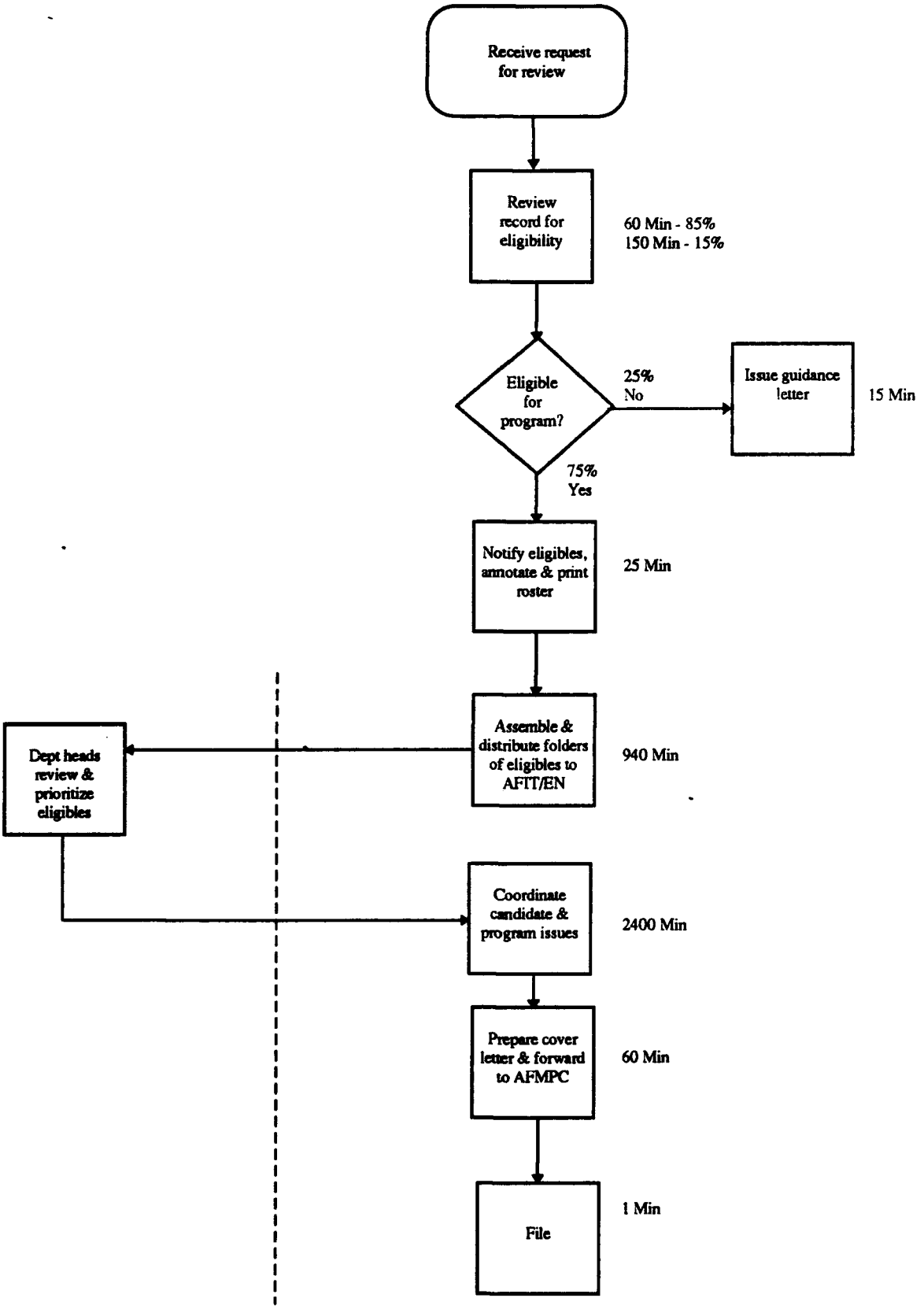

Figure 4-3. PhD Program Support

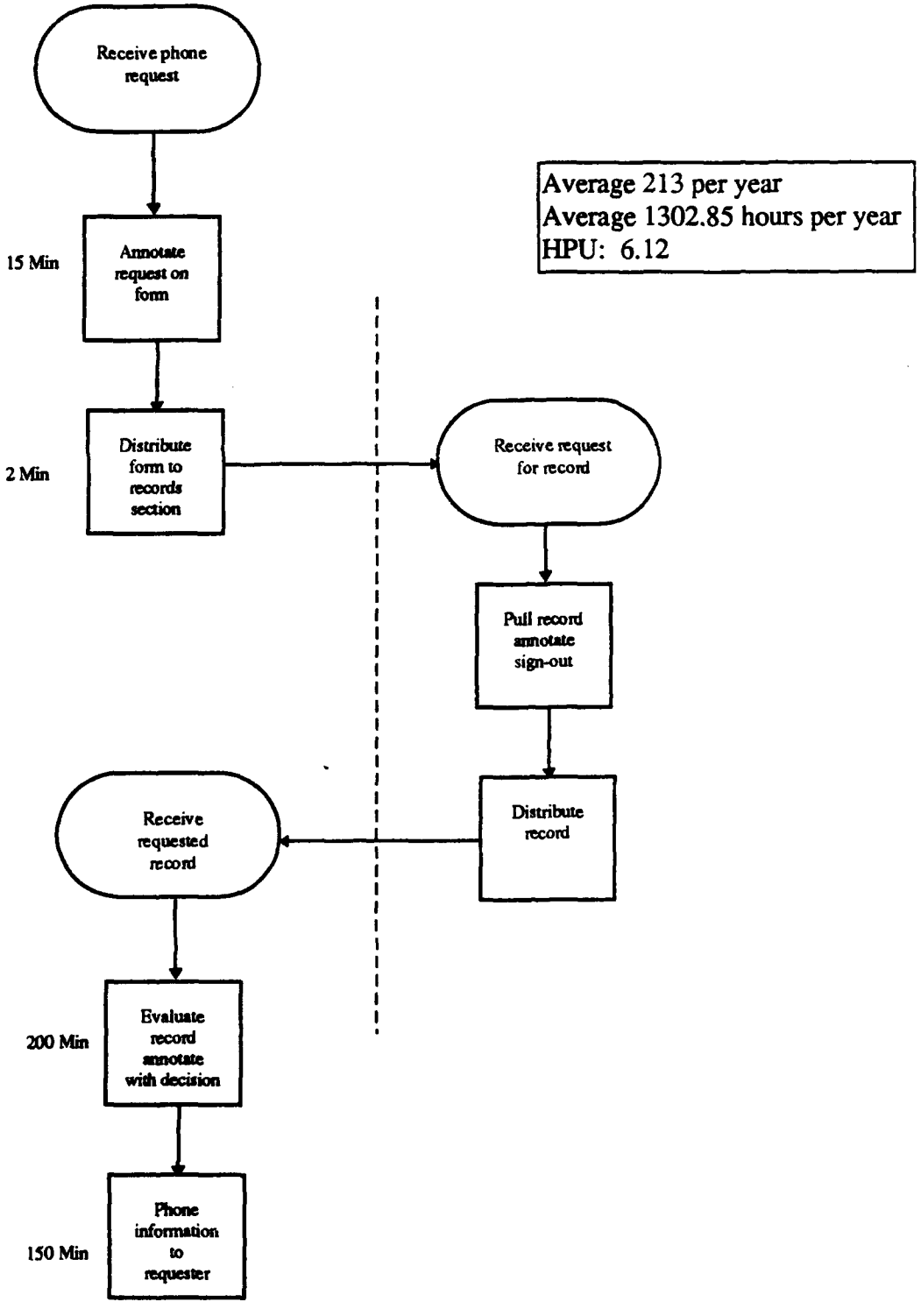

Figure 4-4. MPC Evaluations

preparation of letters becomes automatic since these letters are form letters and completed according to the information in the data base. The computer could select the appropriate letter based on the function being performed. This reduces the average time required to prepare the letter by two thirds. Finally, the refiling of records and letters doesn't exist under the paperless information system since they are already stored on the computer.

These are examples of the more common impacts made to the steps of each process from a paperless information system. Each step of a each process as well as the impact of the paperless information system on that step is discussed below.

Program Eligibility Determination (see Figures 4-1 and 4-5). This process begins with the receipt of a request for an eligibility evaluation. The first step requires a check to see whether the record is attached to the request and then, if it isn't, a request is made to retrieve the record. Under the paperless information system, this step is eliminated since every record is kept in the computer and will be immediately available when the request is received. The next step is to review the record for completeness. With the paperless information system, the time required to perform this review is greatly shortened because the computer contained a list of required items and performed an automated review. The reviewer is then notified of any missing items. If any items are missing, the computer creates the appropriate letter and suspense. If the record is complete, the reviewer conducts an academic evaluation for program eligibility. Under the paperless information system, the computer provides the reviewer with guidelines for this eligibility and shows the reviewer where each record falls within the guidelines. This reduces the time required

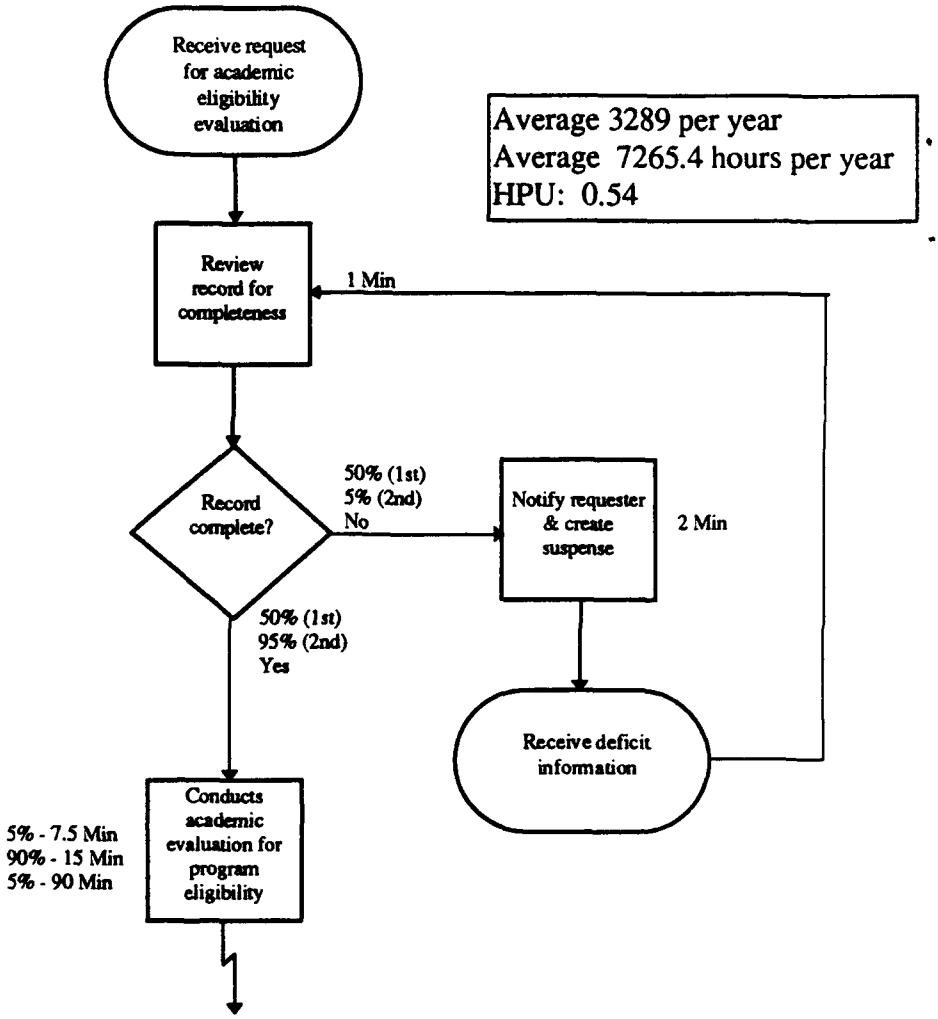

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Figure 4-5. Program Eligibility Determination
(Paperless Information System)

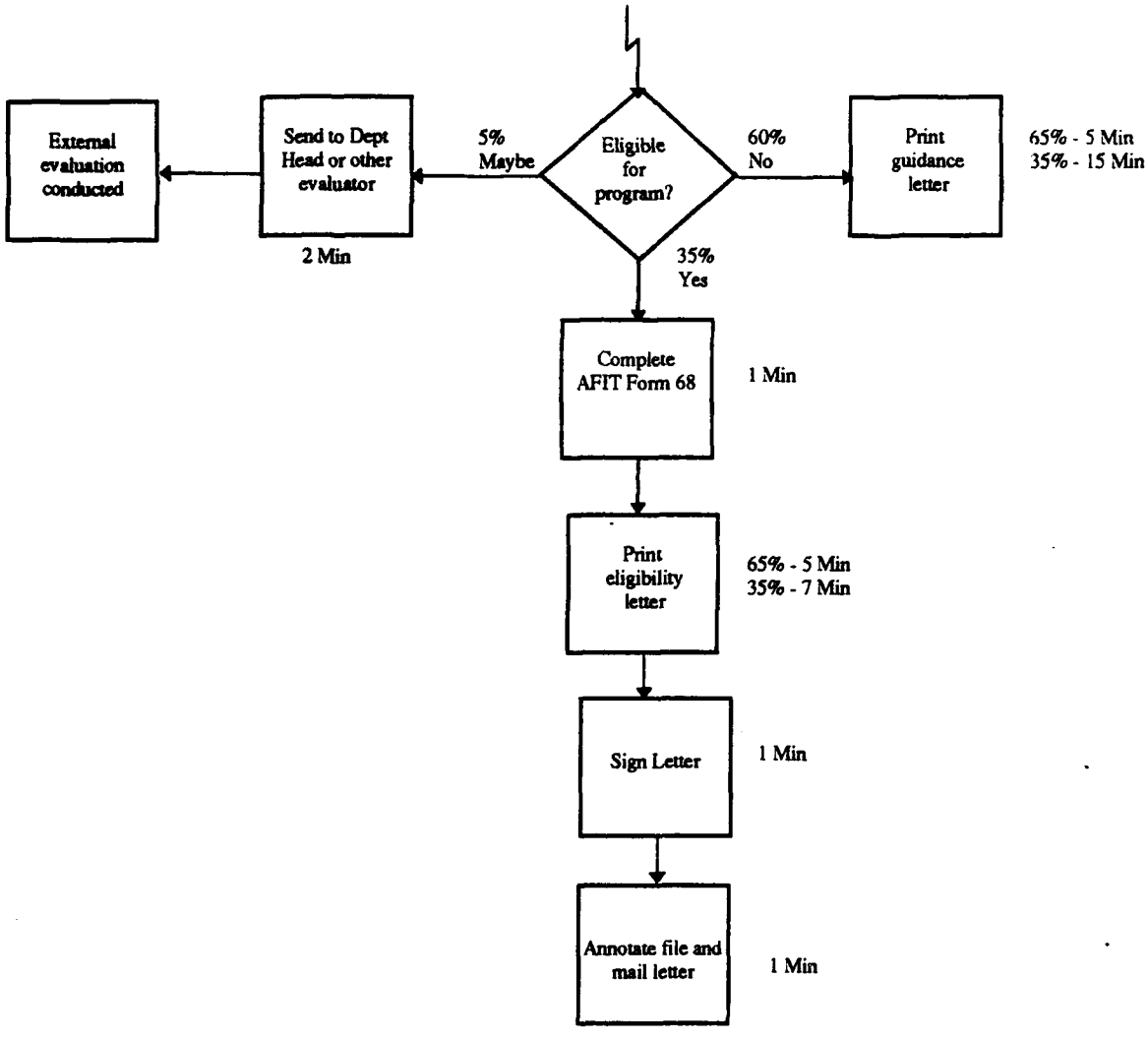

Figure 4-5. Program Eligibility Determination (cont)
(Paperless Information System)

to complete this step by one-half. One possible outcome of this review is the need for an external evaluation. The time required to send the record to the evaluator is reduced to two minutes since E-mail is used to send the record. Another outcome of the review is a determination of noneligibility. This requires the preparation of a guidance letter. Under the paperless information system, the letter is automatically created and distributed by the computer upon the determination of noneligibility. This reduces the time to create and distribute the letter by two-thirds. If the record is reviewed and determined to be eligible, an AFIT Form 68 is completed. The computer automatically completes this form under the paperless informati n sys m. The next few steps involve the preparing, reviewing, signing, and filing of an eligibility letter. Under the paperless information system, a standardized letter is automatically prepared and distributed for review. The review and signing process is reduced once the standardized letter is agreed upon. This would reduce the time for these steps significantly.

Program Selection (see Figures 4-2 and 4-6). This process begins with the receipt of a Report of Information on Personnel (RIP). The reviewer then reads over the RIP to see if the information provided is complete and to look for obvious errors. Next, the RIP is compared with a listing from MPC. Any conflicting information is corrected and coordinated with MPC. Then, the reviewer requests the appropriate records. Under the paperless information system, the reviewer receives both the RIP and the MPC listing on the computer. The computer would highlight missing information, any data fields that are out of a predetermined range, and the differences between the RIP and the MPC listing.

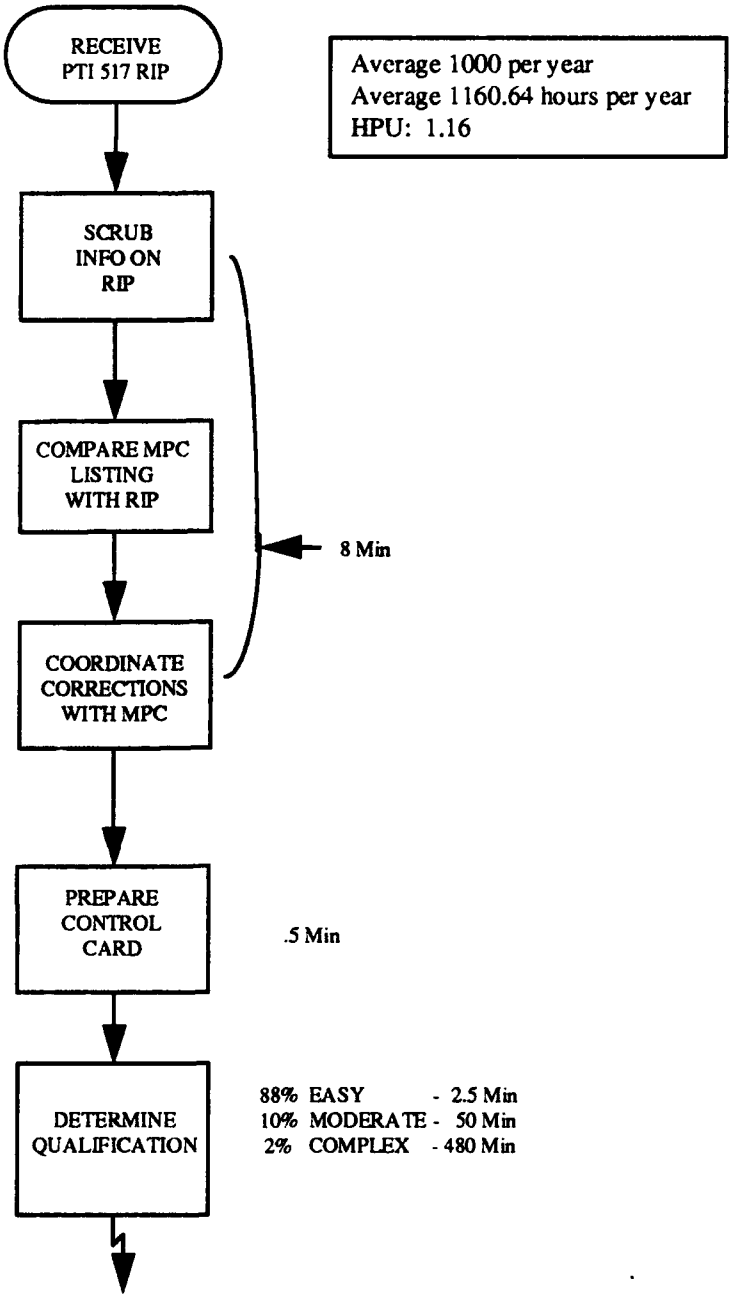

Figure 4-6. Program Selection
(Paperless Information System)

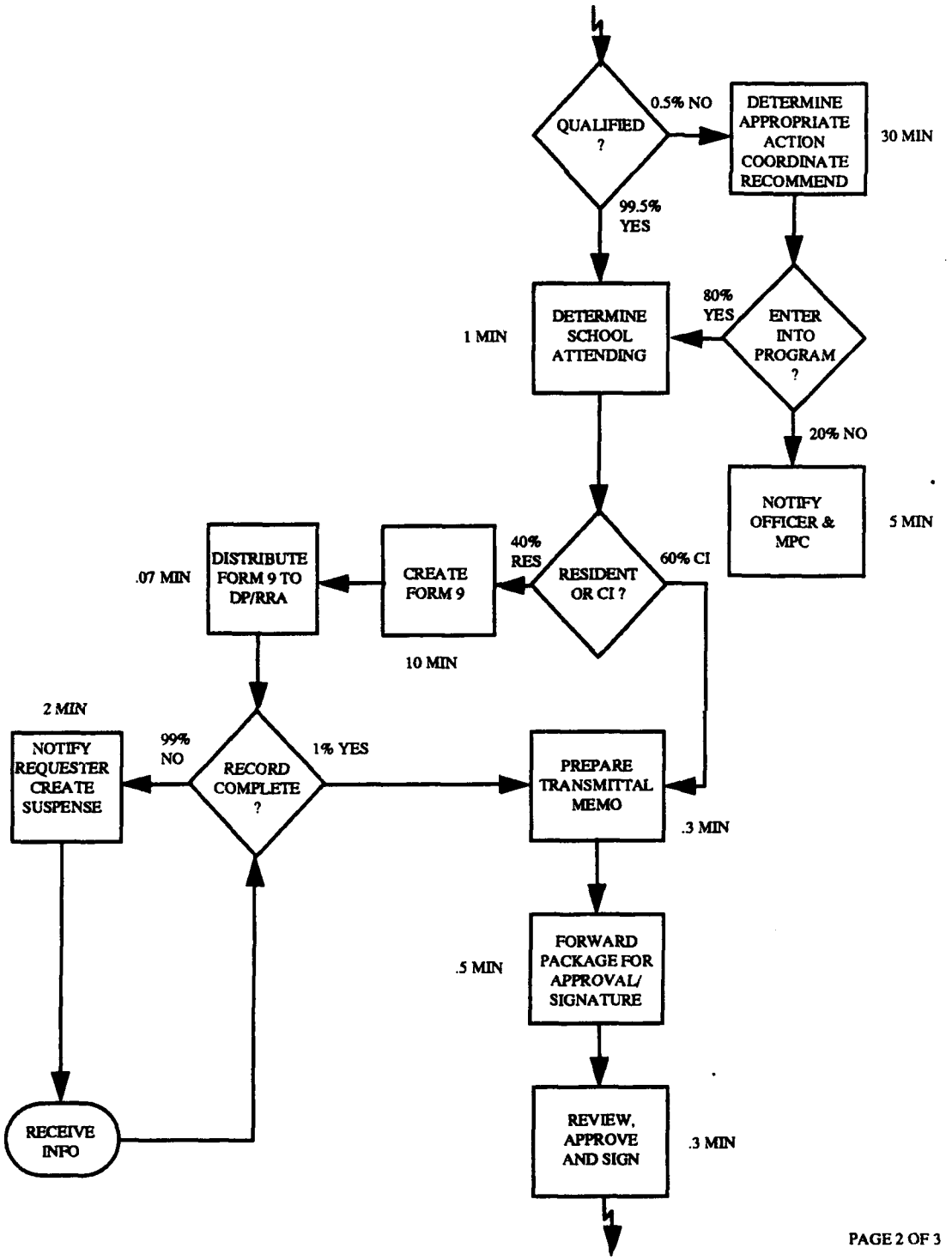

Figure 4-6. Program Selection (cont)

(Paperless Information System)

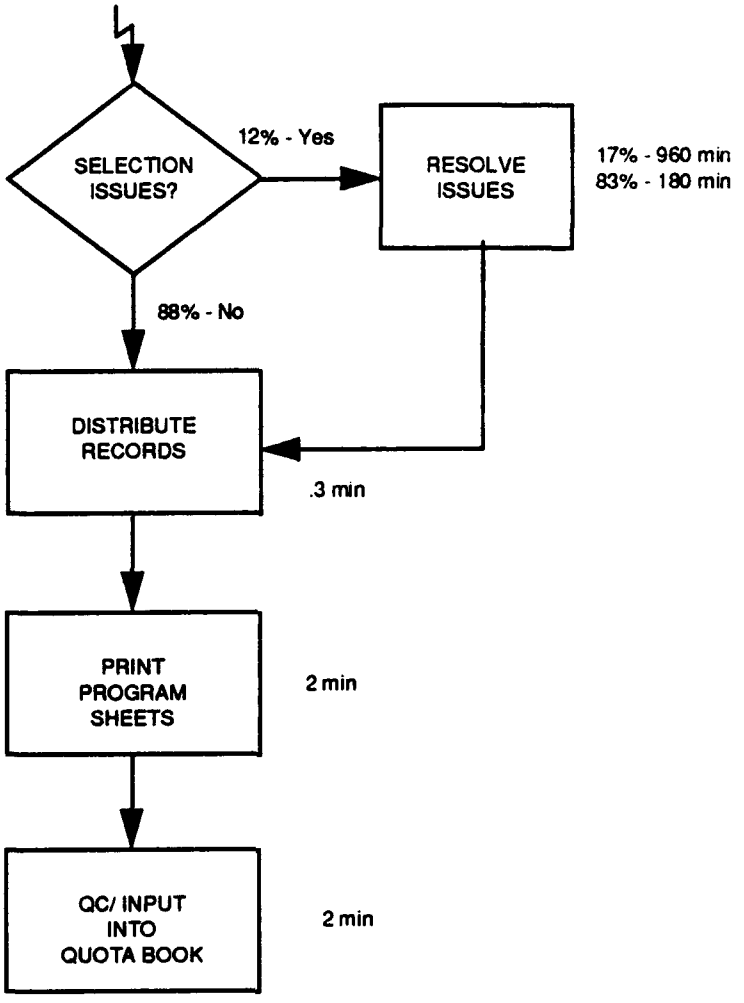

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Figure 4-6. Program Selection (cont)
(Paperless Information System)

The reviewer would coordinate the corrections with MPC through E-mail. The time to complete this process is reduced to eight minutes. In addition, the reviewer doesn't have to request the records since they are already available on the computer. The next step involves completing a control card which is used as a routing checklist for the rest of the process. Since this card is on the computer in the paperless information system, it takes one half of the time to complete. Determining the qualifications is the next step. The paperless information system provides the guidelines for qualification for each program and indicates to the reviewer whether the request meets those guidelines. This reduces the evaluation time by one-half. If the request is not qualified, the reviewer determines the appropriate actions and makes a recommendation to the division head. The paperless information systems speeds up this process by allowing the reviewer to choose among a selection of actions and forward those with the recommendation by using E-mail. If the request is determined not qualified, the reviewer prepares a notification letters to the requester and MPC. Under the paperless information system, the computer automatically create and distributes the letter to the requested officer and prepares an E-mail notification to MPC. If the request is determined to be qualified, the appropriate school is selected. Since this determination is based on the degrees offered and the number of slots available at each school, the computer could match this information against the request and indicate the options available to the reviewer. This reduces the time for this step by one-third. If the determination is made for attending school in residence, then an AF Form 9 is completed and forwarded. Since this form is not yet automated, the paperless information system has no affect on these steps. After the AF Form 9 is distributed, the record

automatically checked for completeness. If the record is not complete, the requester is notified and a suspense is created. In the paperless process, the computer would create and distribute the notification letter and add the suspense to the suspense file. For those selected for attendance at a civilian institution and for those selected to attend school in residence (after the records are checked for completeness), a transmittal letter is prepared and the entire package is forwarded, reviewed, and signed. Since the entire package, including the transmittal letter, can be prepared, forwarded, and reviewed within the paperless information system, the time required for these steps is reduced. If there are issues with the selection that need resolved, these are worked. The resolving of these issues does not change under the paperless information system. Next the records are distributed, the data is entered into the student database, program sheets are printed, and the quota is entered into the quota book. Under the paperless information system, the records are distributed by E-mail, the data is already in the student database, program sheets are printed automatically, and the filled quota is stored in the quota data base. These automated steps reduce the time required by over fifty percent.

PhD Program Support (see Figures 4-3 and 4-7). This process begins with the receipt of a request for the review of the potential student's records. The next step requires reviewing the record to determine eligibility. As in the other processes, this step is reduced to one-half of the time due to the automated eligibility guidelines and initial evaluation in the paperless information system. After the evaluation is done, the appropriate letters are completed. As stated before, since the computer already has the

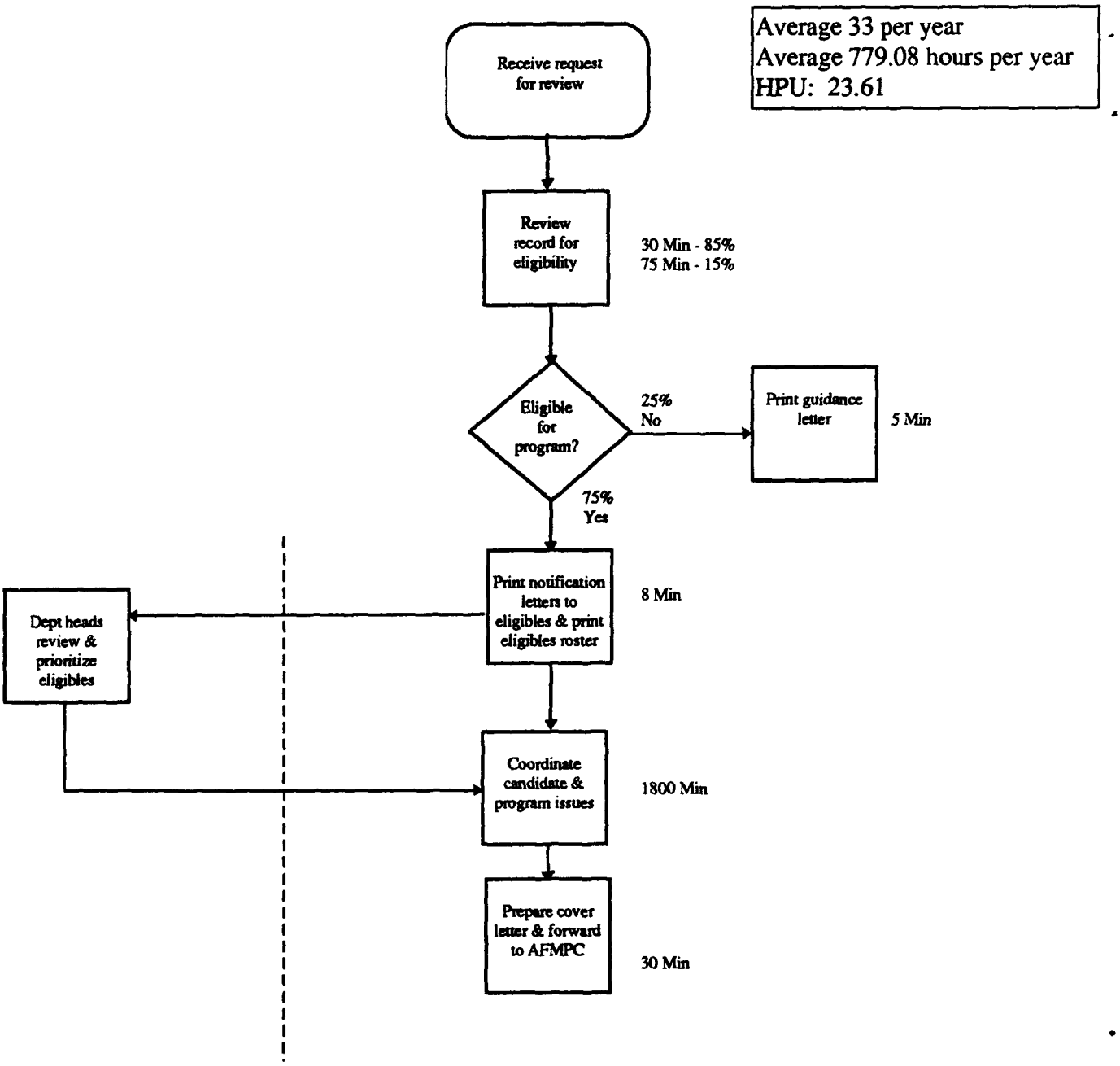
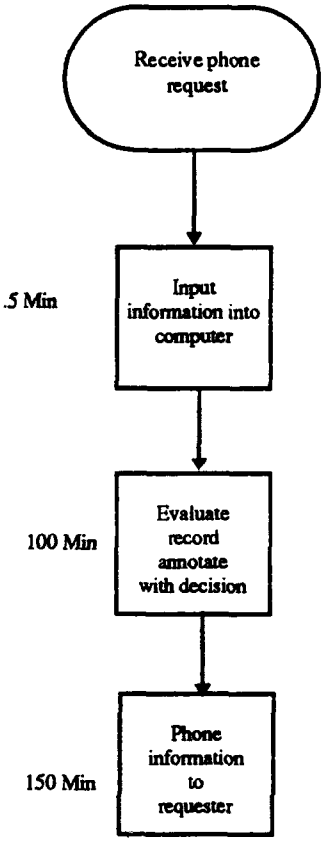


Figure 4-7. PhD Program Support
(Paperless Information System)

appropriate letters on file, the creation and distribution of these letters is automatic and the time would be reduced to one-third of the original time. The next step requires the creation of folders containing the pertinent documents for each eligible. These folders are then sent to the AFIT Engineering School where the department heads meet to review and prioritize the eligibles. These folders (and the step to assemble them) is eliminated on the paperless information system. All of the pertinent information on each eligible is already assembled in "folders" in the computer. The department heads can review this information directly on their computers. After the review by the department heads, the records return to AFIT/RRE with questions and concerns that must be addressed. Currently, an average of forty hours is spent addressing those issues. Much of that time is spent looking up information in the eligibles' records, making phone calls, and reviewing program eligibility guidelines. Under the paperless information system, the eligibles' records and the program eligibility guidelines are in the computer. Therefore, searches of this information are much quicker. The time required to complete this step is reduced by 25 percent to thirty hours. The next step is the preparation and forwarding of the cover letter. As with other letters, this is be reduced to one-third of the time under the paperless information system. The final step of filing the paperwork is eliminated since the computer would have already contains all the paperwork

MPC Evaluations (see Figures 4-4 and 4-8). The process for MPC evaluations begins with the receipt of a phone request. The first few steps in this process involve annotating a form with information (such as name, social security number, etc) and



Average 213 per year
Average 889.28 hours per year
HPU: 4.18

Figure 4-8. MPC Evaluations
(Paperless Information System)

sending this form to the Records Division to request the appropriate records. These steps require 17 minutes to perform. Under the paperless information system, these steps are combined into one step. This step requires just the entering of one piece of information onto the computerized form (just the name or social security number for example). The computer would then retrieve the rest of the required information from the records database. This step should take an average of one half of one min. The next step involves the evaluation of the record and the annotation of the decision. The paperless information system contains the evaluation guidelines and performs the initial evaluation of the record. This reduces the time required for this step to 100 minutes. Finally, since the last step is completed by telephone, the paperless information system would have no impact on this step. However, a standard E-mail message could replace the phone call.

Work Process Comparison (see Table 4-4)

Each of the four processes discussed above results in decreased completion times when transformed into a paperless information system. These reductions occurred because almost every step in every process had a reduction in time as a benefit of the paperless information system. The reduced and eliminated steps are comprised of primarily administrative operations. Administrative operations such as filing, comparing, and word processing provide the largest time savings when converted to a paperless information system. Table 4-4 shows the overall affect of the transformation to a paperless information system on each process. These processes have time savings ranging from 31.74 percent to 75.38 percent with an overall savings of 64.84 percent. More importantly, the number of hours saved ranged from 413.57 to 5476.41. An overall time

savings of 8515.5 hours is realized on these four processes when put into the paperless information system.

Table 4-4. Process Comparisons

		Before Transformation		After Transformation			
Process	**Average Yearly Output**	**Average Yearly Hours**	**HPU**	**Average Yearly Hours**	**HPU**	**Decrease in hours**	**% decrease in hours**
Program Eligibility Deter-mination	3289	7265.40	2.21	1788.99	0.54	5476.41	75.38
Program Selection	1000	3109.53	3.11	1160.64	1.16	1948.89	62.67
PhD Program Support	33	1455.71	44.11	779.08	23.61	676.63	46.48
MPC Evalua-tions	213	1302.85	6.12	889.28	4.18	413.57	31.74

V. Conclusions and Recommendations

Review

AFIT/RR has a need to improve and expand services using a smaller operating budget. One promising solution is to eliminate the paperwork required to perform the AFIT/RR functions. By eliminating paperwork, AFIT/RR expects to improve productivity and customer services while reducing the storage costs, supply costs, and time required to complete functions. Even though there are other benefits associated with a paperless information system, this thesis team chose to research productivity.

In administrative and service organizations productivity is difficult to define and measure. For the purposes of this thesis the DOD definition was used. This definition of productivity focuses on the efficiency with which organizations utilize labor resources to accomplish their missions. Efficiency is defined as a means of accomplishing the right things with the lowest possible expenditure of resources. Based on these definitions, the hours per unit of work (HPU) is chosen as the measure of productivity. Next, several paperless techniques are discussed. These techniques are common in the information systems of today. In addition, these techniques demonstrate productivity savings that are useful for the needs of this thesis. Finally, chapter two presented the techniques and productivity savings found in two similar applications. These applications are particularly relevant to AFIT/RR because the functions of records management; data storage; request processing (by both paper and phone); information processing for determinations, approvals, and so on; work process monitoring; transmitting of replies; and so on are

virtually the same. With this base of knowledge, the next issue is to discuss the thesis methodology.

The methodology primarily consisted of five research objectives and techniques for accomplishing the objectives. The first objective defines productivity and developed measures of productivity as they relate to AFIT/RRE. The second objective defines the work processes used by AFIT/RRE to accomplish their mission, determines that only a subset of the processes require measuring, and finally measures the productivity of the selected processes. Next, paperless techniques are applied to the current information system to develop a representative paperless information system model. The fourth objective remeasures the productivity of the selected processes subject to the paperless information system model. The final objective compares and contrasts the two sets of measurements.

The product from accomplishing the research objectives determines the nature (which paperless techniques proved useful) and extent (the compared measures of productivity) to which a paperless information system affects the productivity of the AFIT/RRE. Data is collected from AFIT/RRE on the work process used to accomplish it's mission. These data consist of work process flow charts, frequency values, time requirements, and discussions from workers on the details of the selected processes. Several averages and the corresponding HPUs are calculated. From these calculations several conclusions are made.

Conclusions

Assuming the paperless models developed here are reasonable, AFIT/RRE can expect to receive a productivity increase of approximately 65 percent from implementing a paperless information system. This value is calculated from a weighted average of the four processes selected from the Pareto analysis. However, based on the methodology used to calculate this value, an expected range of productivity increase is more appropriate. This range is 32 to 75 percent. Furthermore, additional benefits such as reduced idle time that documents spend in the system, improved document and decision quality, increased manager control, and others are possible. Even though the actual paperless information system used in AFIT/RRE may be different than the one proposed in this thesis, it is the opinion of this research team that the findings form a basis for estimation of productivity increases. In addition, the findings are consistent with those reported by companies with similar administrative applications.

If a paperless information system is installed, AFIT/RRE will need to measure productivity to determine the actual productivity change. The productivity definitions, measures, and other factors described in chapter two are appropriate for use by AFIT/RRE. When reviewing productivity measures, management will need to monitor the other factors that affect productivity. During an interview, an AFIT/RRE worker explained the detail of one of her work processes and stated that there was no way this work could be accomplished with a paperless information system. After leaving the interview, Capt Shrader and Capt Bihary agreed that nearly all the administrative portion of the work process was achievable by a paperless information system which would

greatly improve the productivity of this worker. Finally, the hours saved are now available to perform other AFIT/RR functions needed to meet new requirements or improve services.

Recommendations

There are many other issues related to this thesis that other teams could research. Their research would help AFIT/RR continue toward its goal of determining all of the benefits and disadvantages of implementing a paperless information system. Some of these other issues come only from the overall goal of AFIT/RR and others were discovered during the research for this thesis. Other thesis teams should consider the following unresolved issues:

Research into the other benefits of a paperless information system. For example, the improved control and work organization may reduce the idle time documents spend in the AFIT/RRE system or with the ability to quickly gather accurate information and develop statistics the quality of decisions could improve.

Research of the benefits from incorporating AFIT/RR external interfaces into the paperless information system. For example, many of the work processes are initiated with the receipt of a request which if received electronically could save considerable time. In addition, if replies were transmitted using electronic means savings of paper, time, mail, and others are achievable. Possible interfaces are with the Air Force Military Personnel Center (MPC) for data and file transfers and the base educational offices for processing of requests and evaluations.

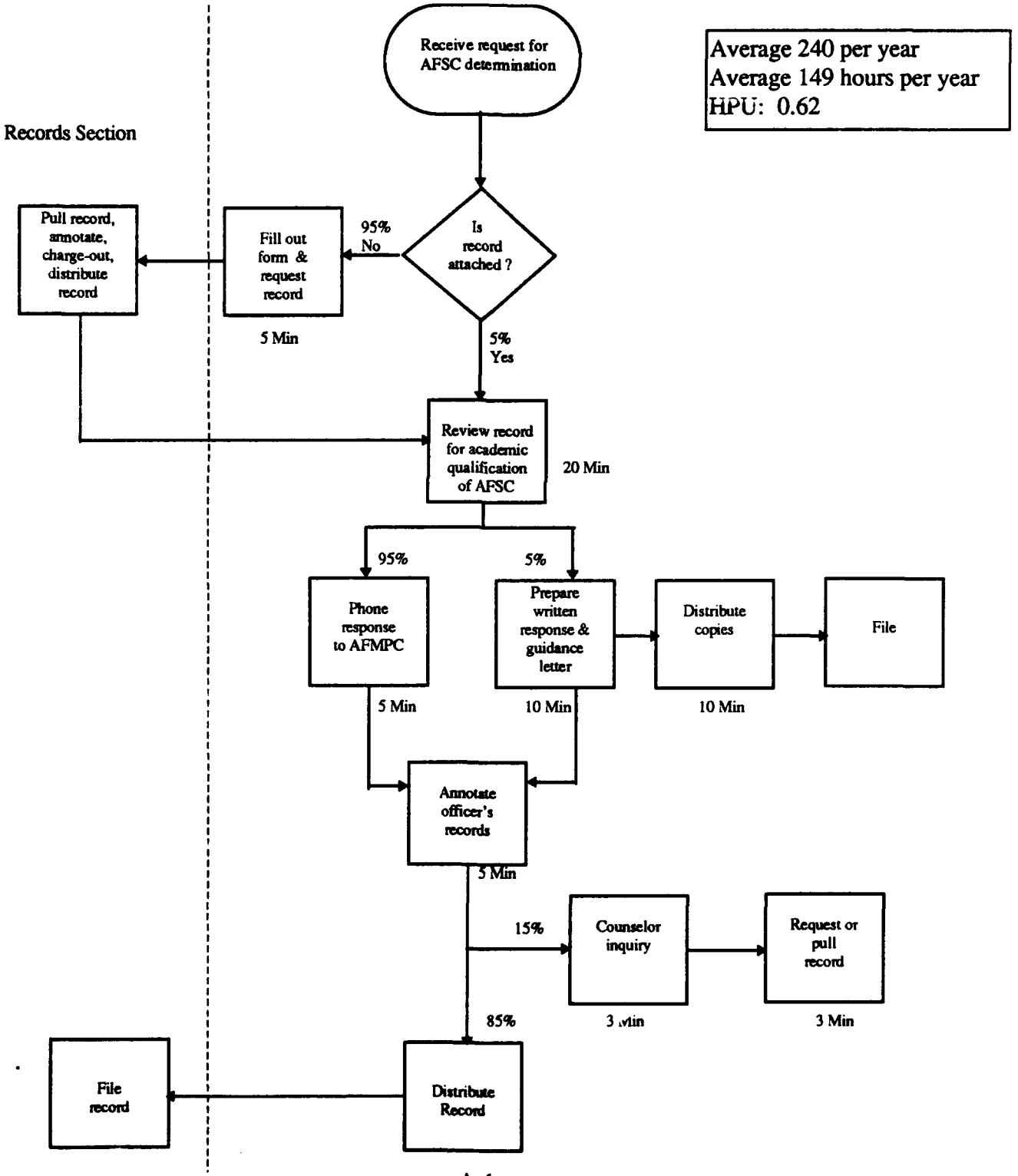
Research into the addition of other capabilities for inclusion into the AFIT paperless information system. For example, in the PhD Program Support work process a group decision support capability within the AFIT network could increase the productivity of the various department heads during their review procedure.

Research of the appropriate work flows, technique implementation details, and others would benefit AFIT/RR if an expanded paperless information system is pursued. As stated in this thesis, it requires more than the hardware to implement a beneficial paperless information system. The work processes might need restructuring to better utilize the system. In addition, experiments using the various paperless techniques could improve the usability, efficiency, and effectiveness of a paperless information system. Questions as to the best method for data entry or form letter generation are not easily answered.

The most significant recommendation is to develop a prototype system for AFIT/RRE based on the paperless work processes identified in chapter four. Then a comparison of this thesis' theoretical estimates could be made against a representative system.

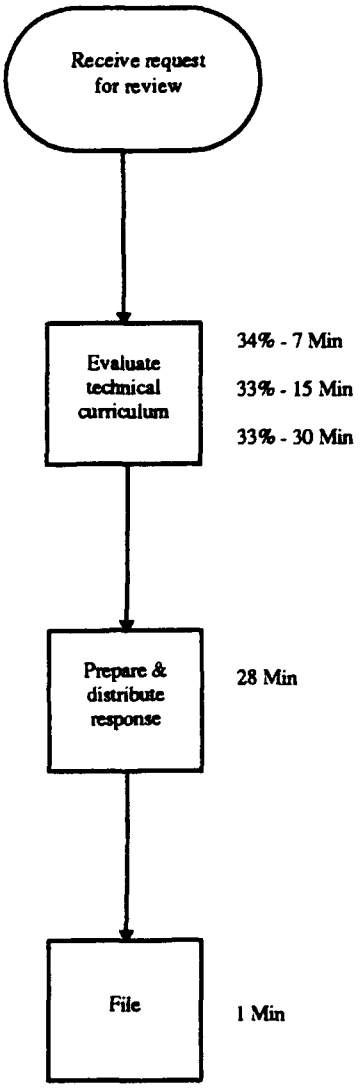
Appendix: AFIT/RRE Work Processes

AFSC Determination

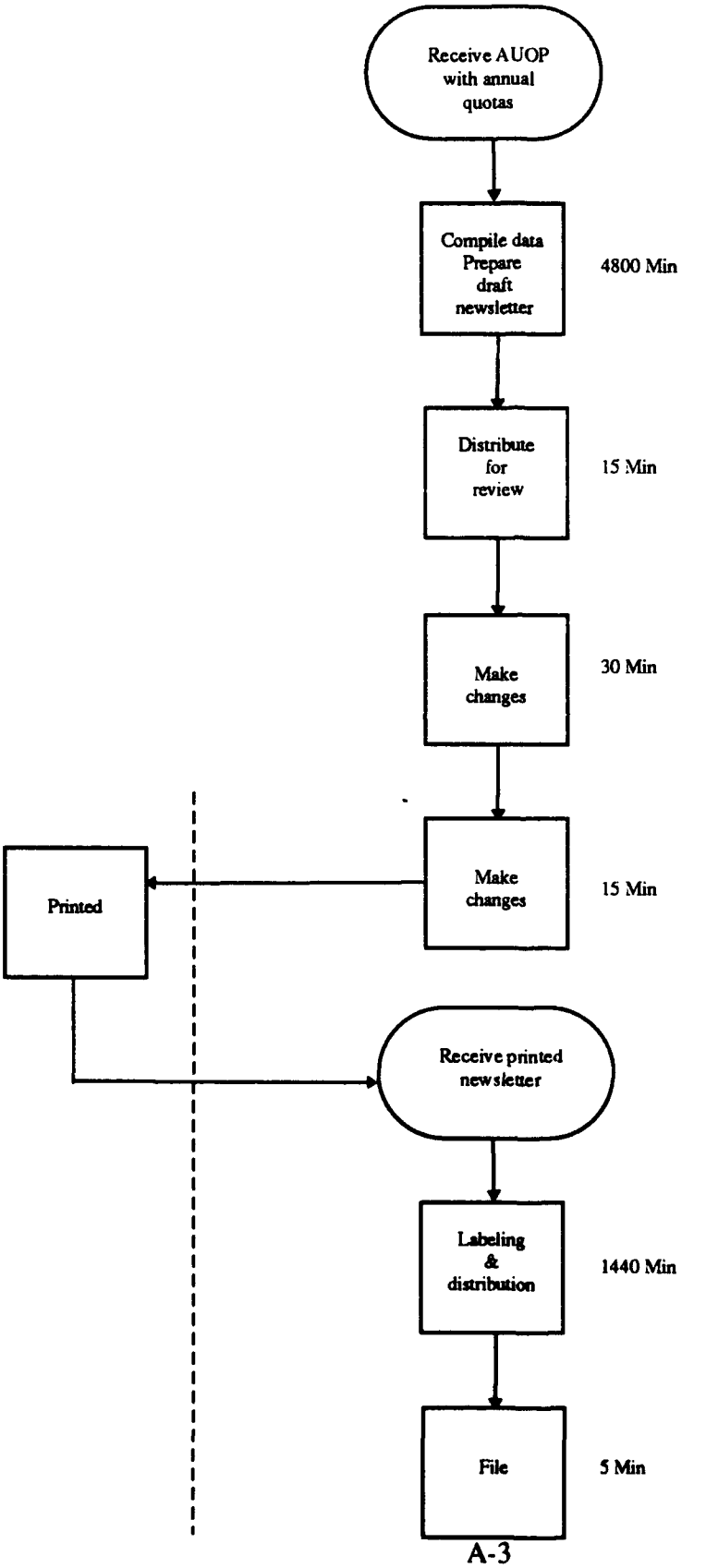


ROTC Technical Curriculum Review

Average 606 per year
Average 466.92 hours per year
HPU: 0.77

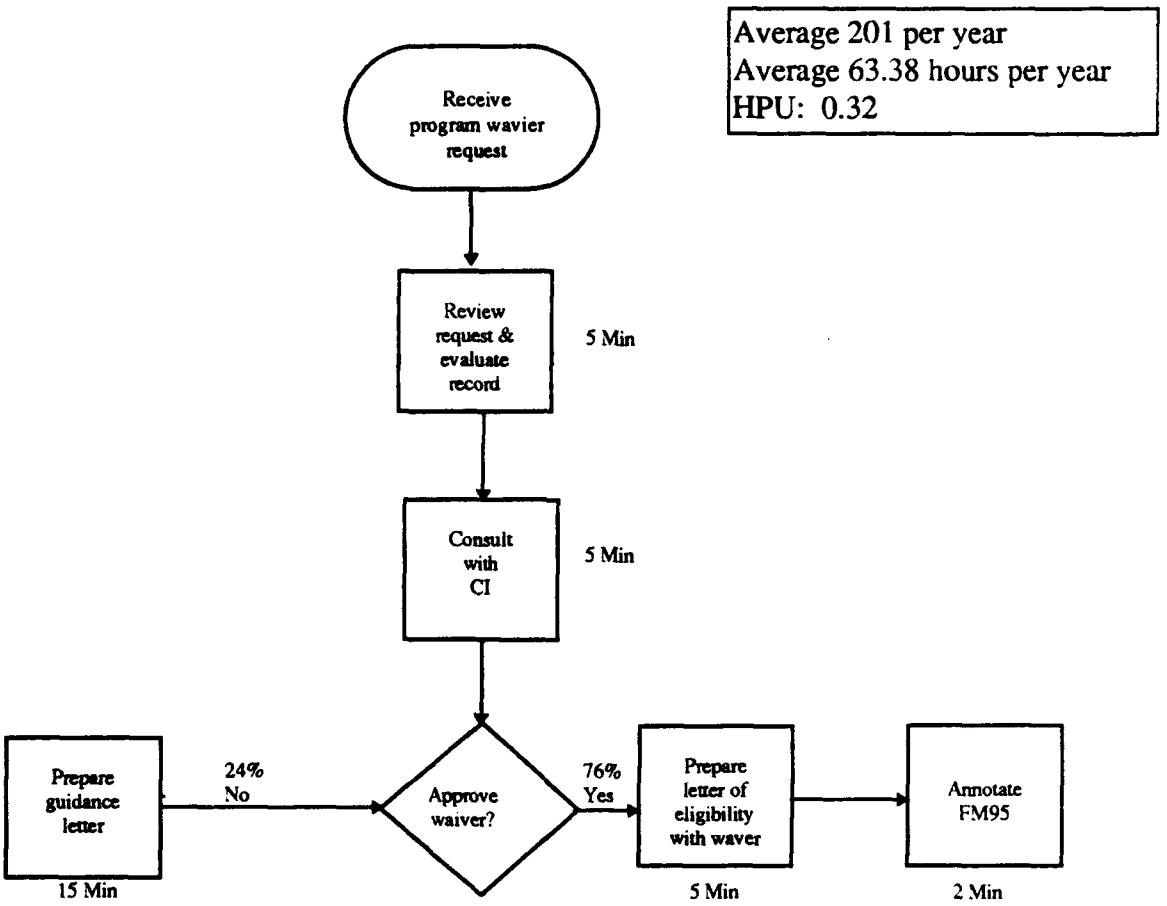


AFIT Education Newsletter

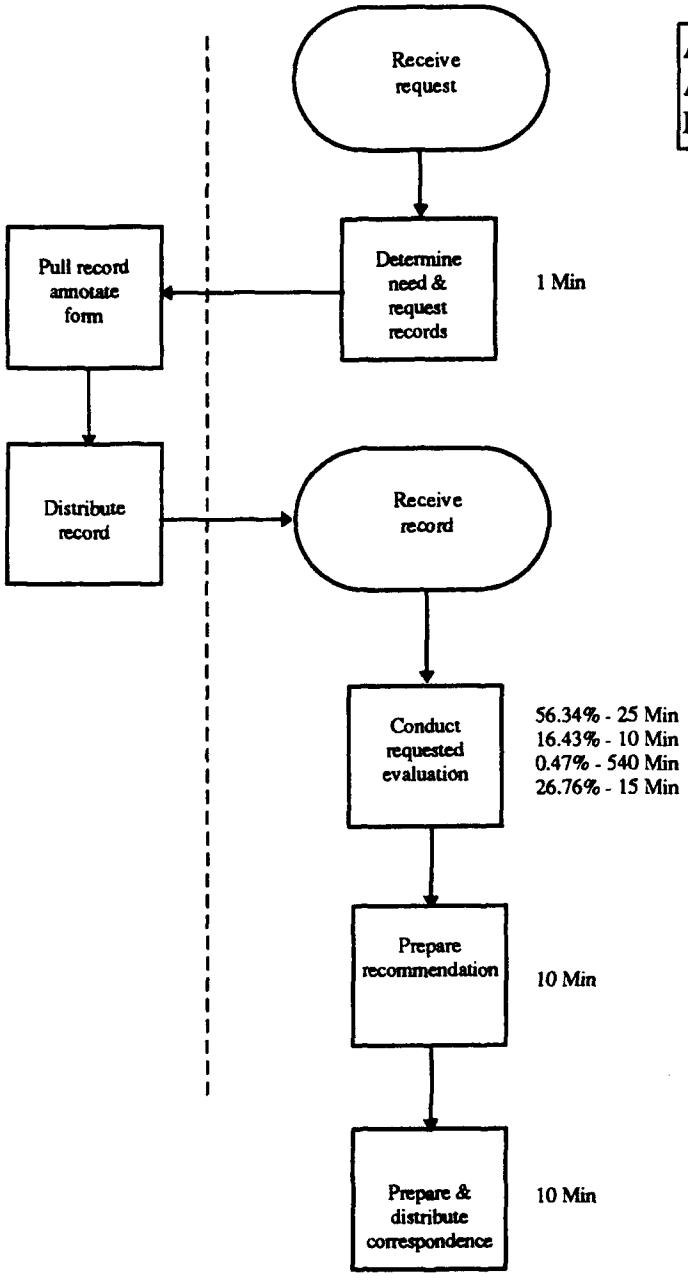


Average 1 per year
Average 105.08 hours per year
HPU: 105.8

Process Medical Program Waiver Request

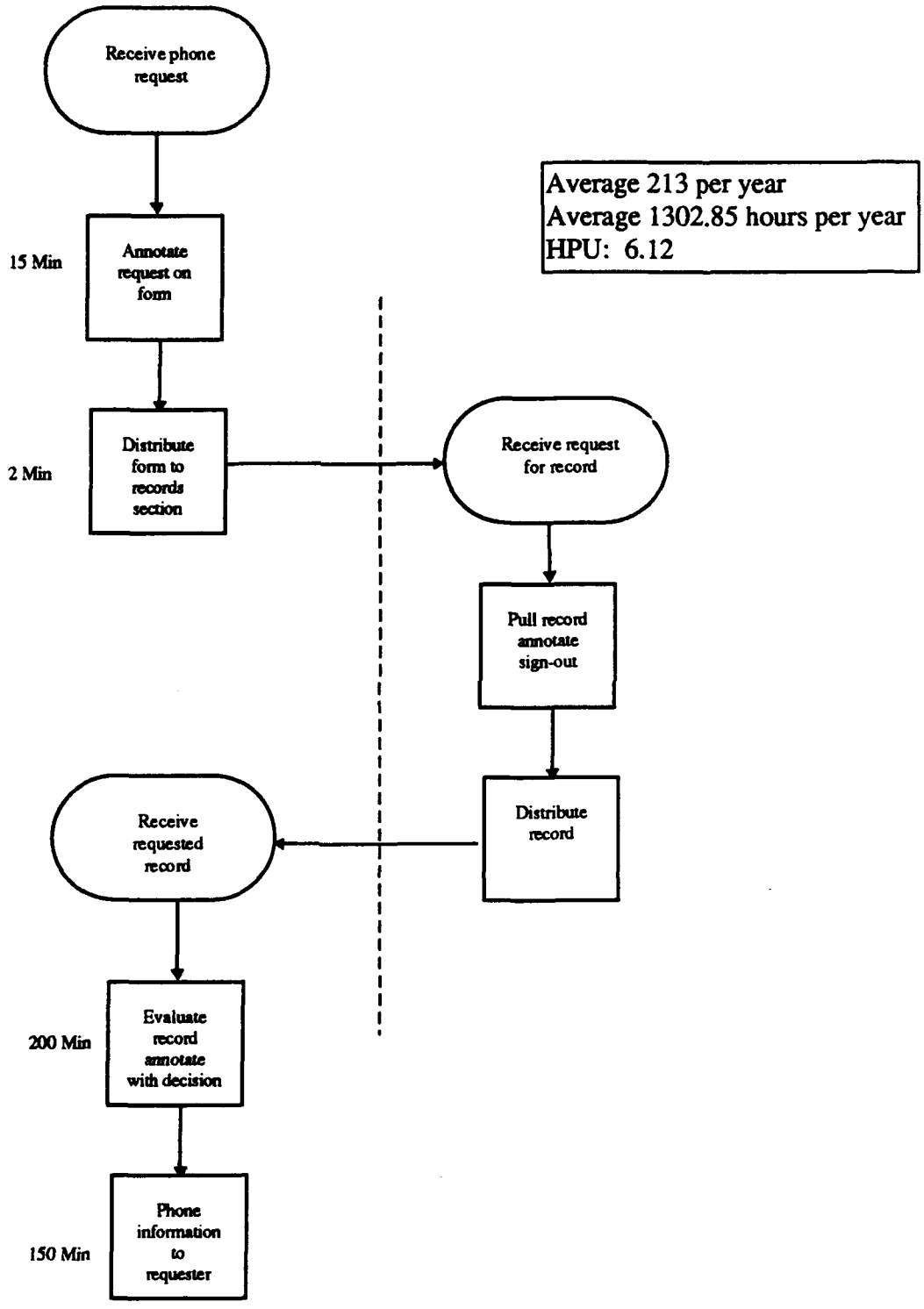


Special Program Evaluations

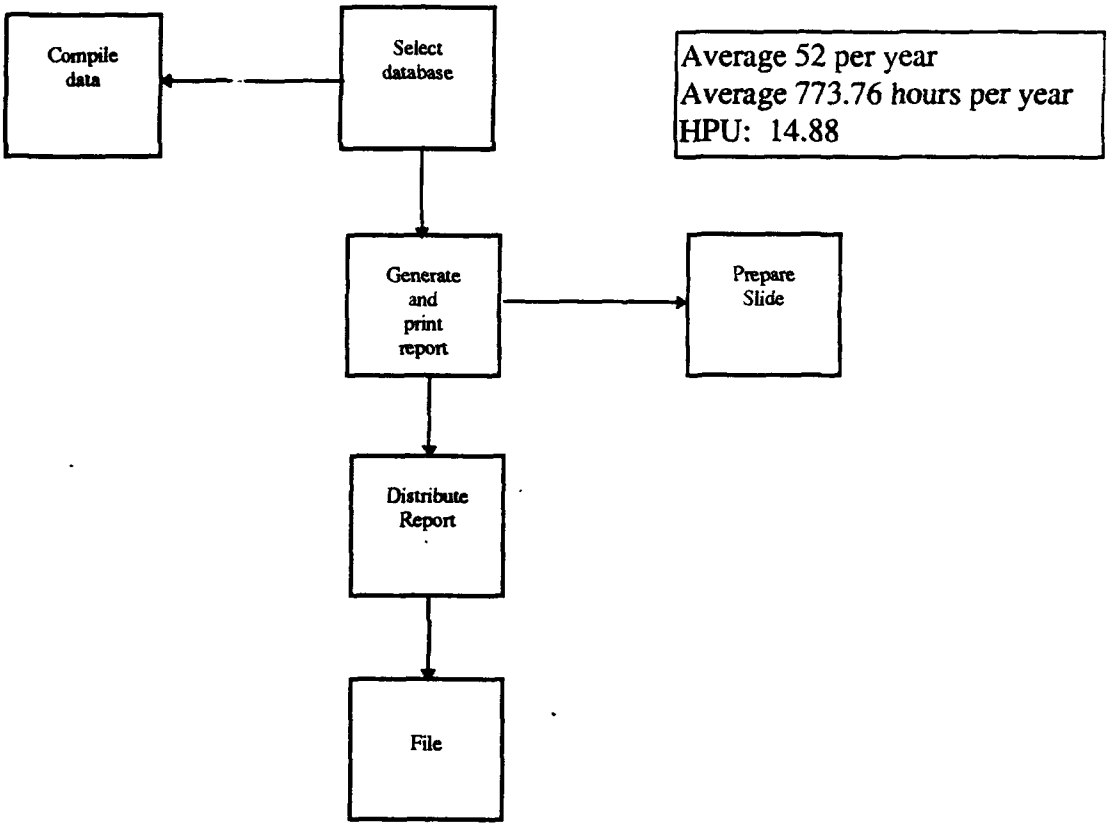


Average 420 per year
Average 309.96 hours per year
HPU: 0.74

MPC Evaluations

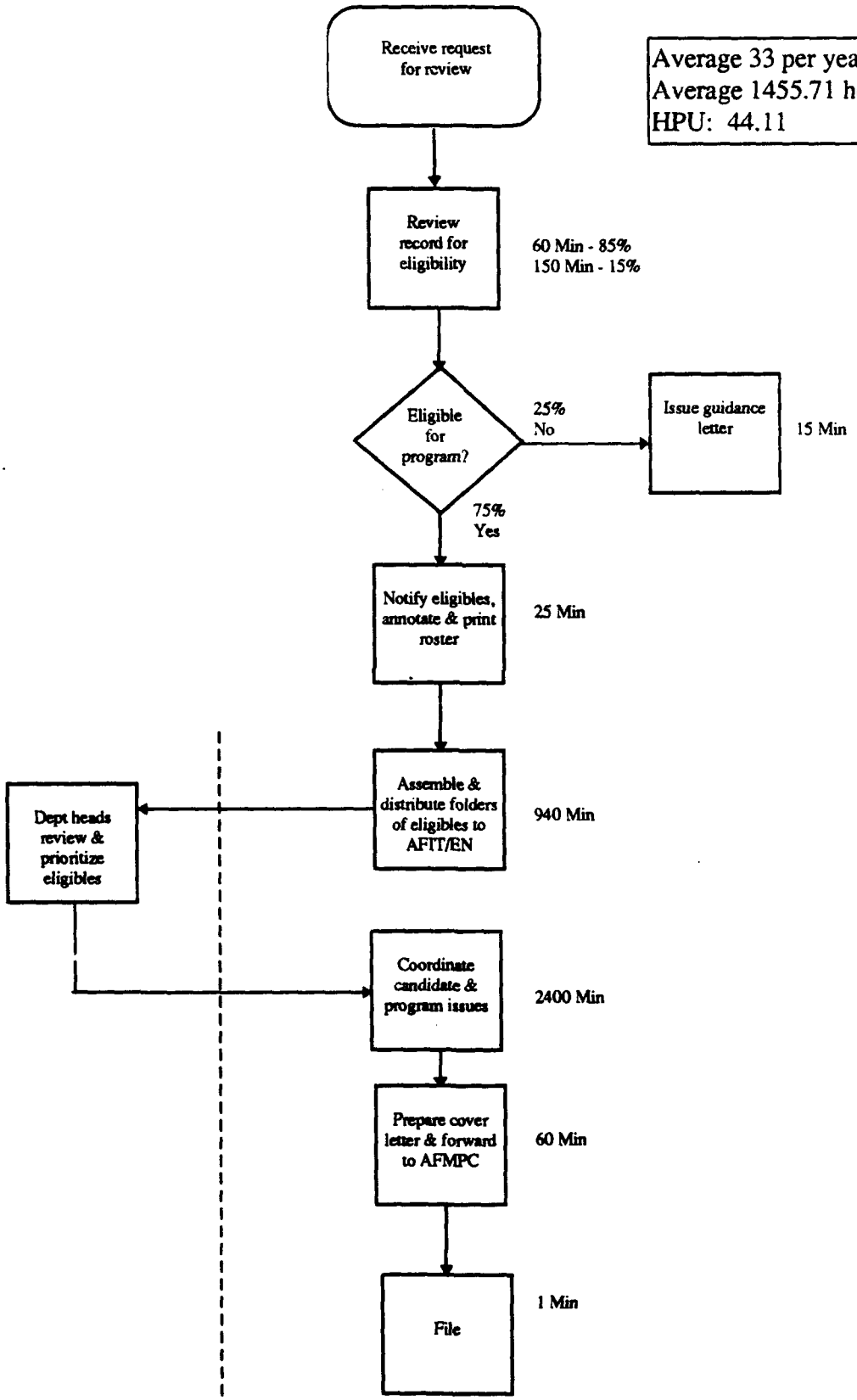


Generate Selection Reports

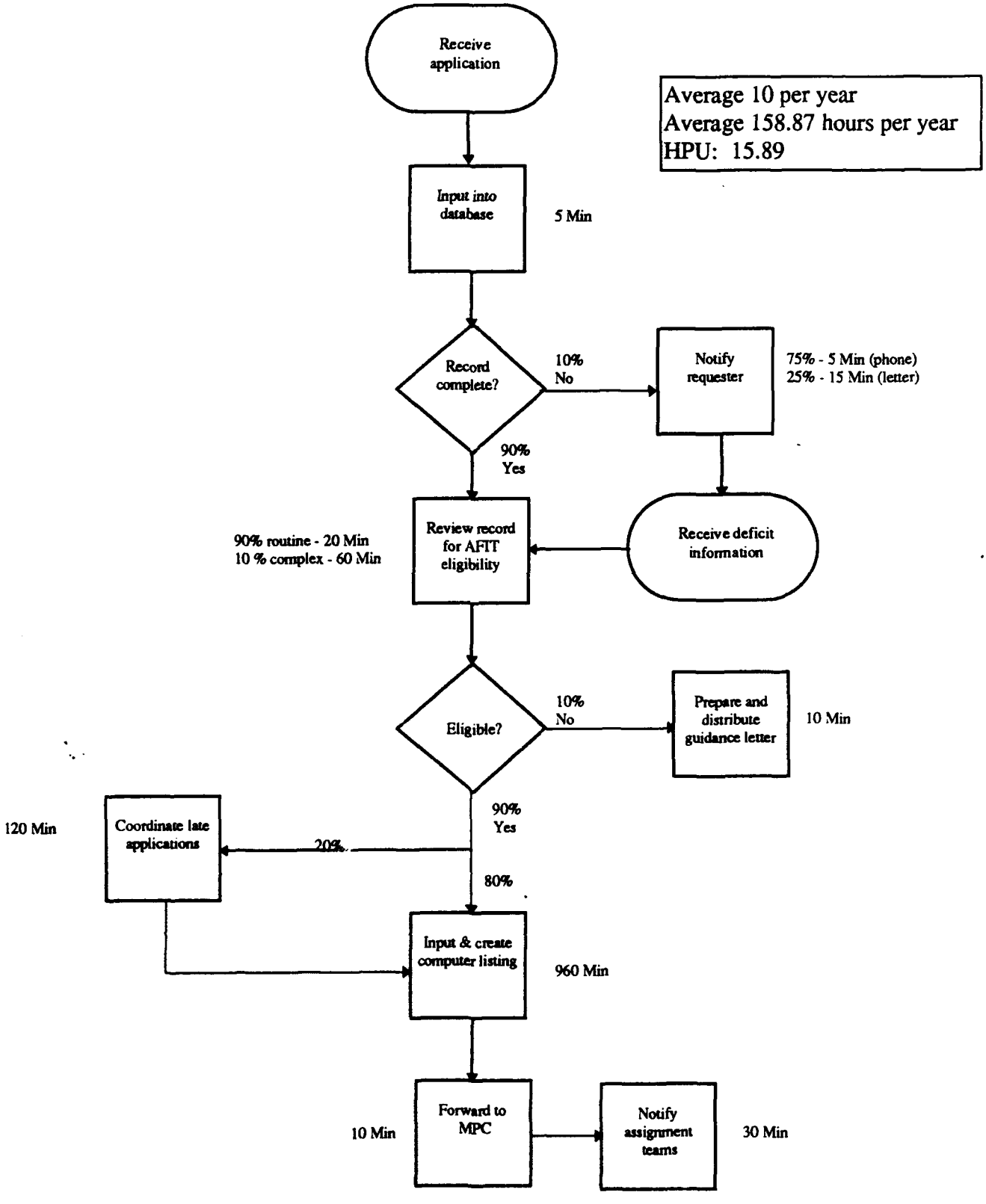


50% - 480 Min
38% - 960 Min
12% - 2400 Min

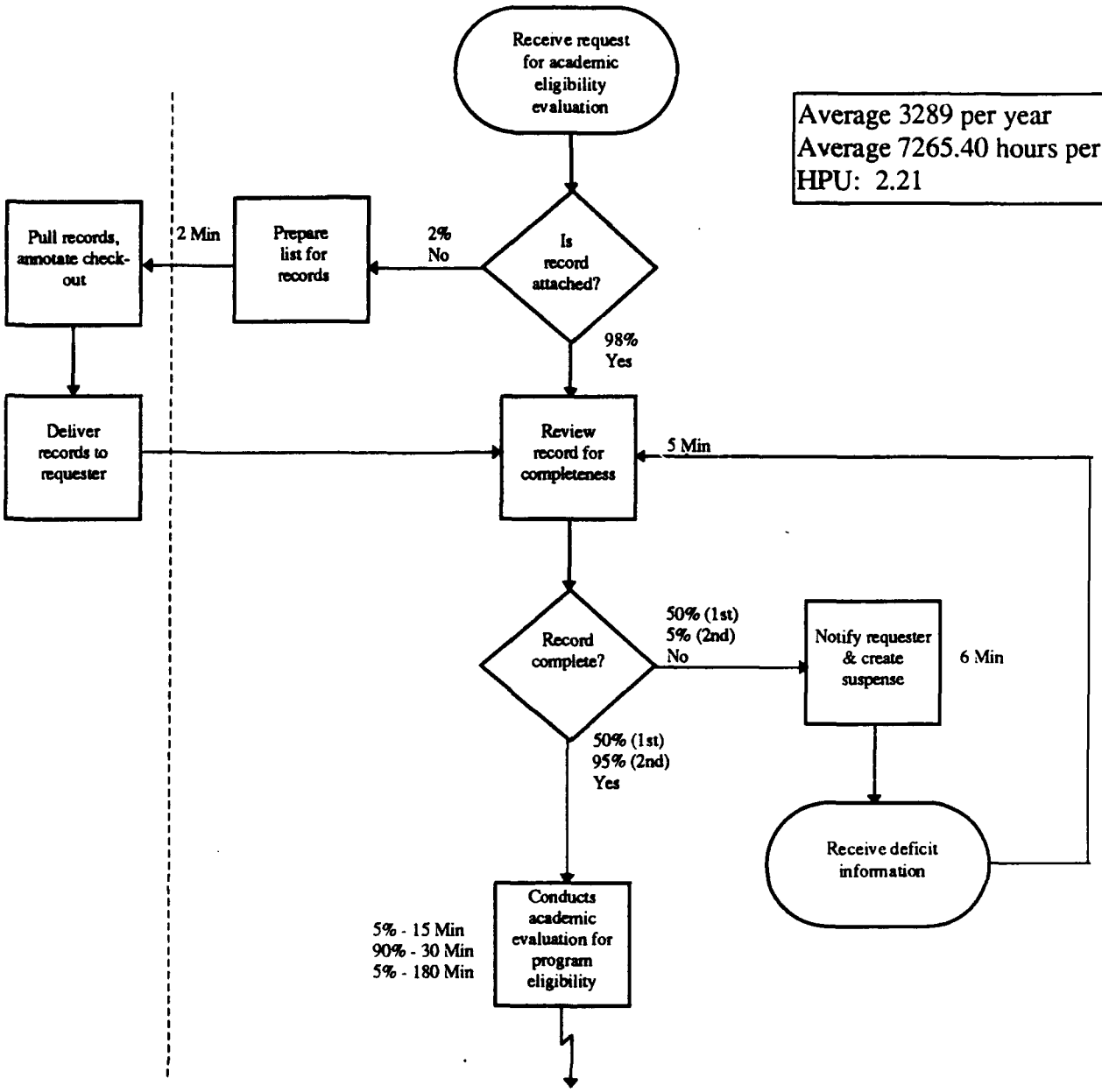
PhD Program Support



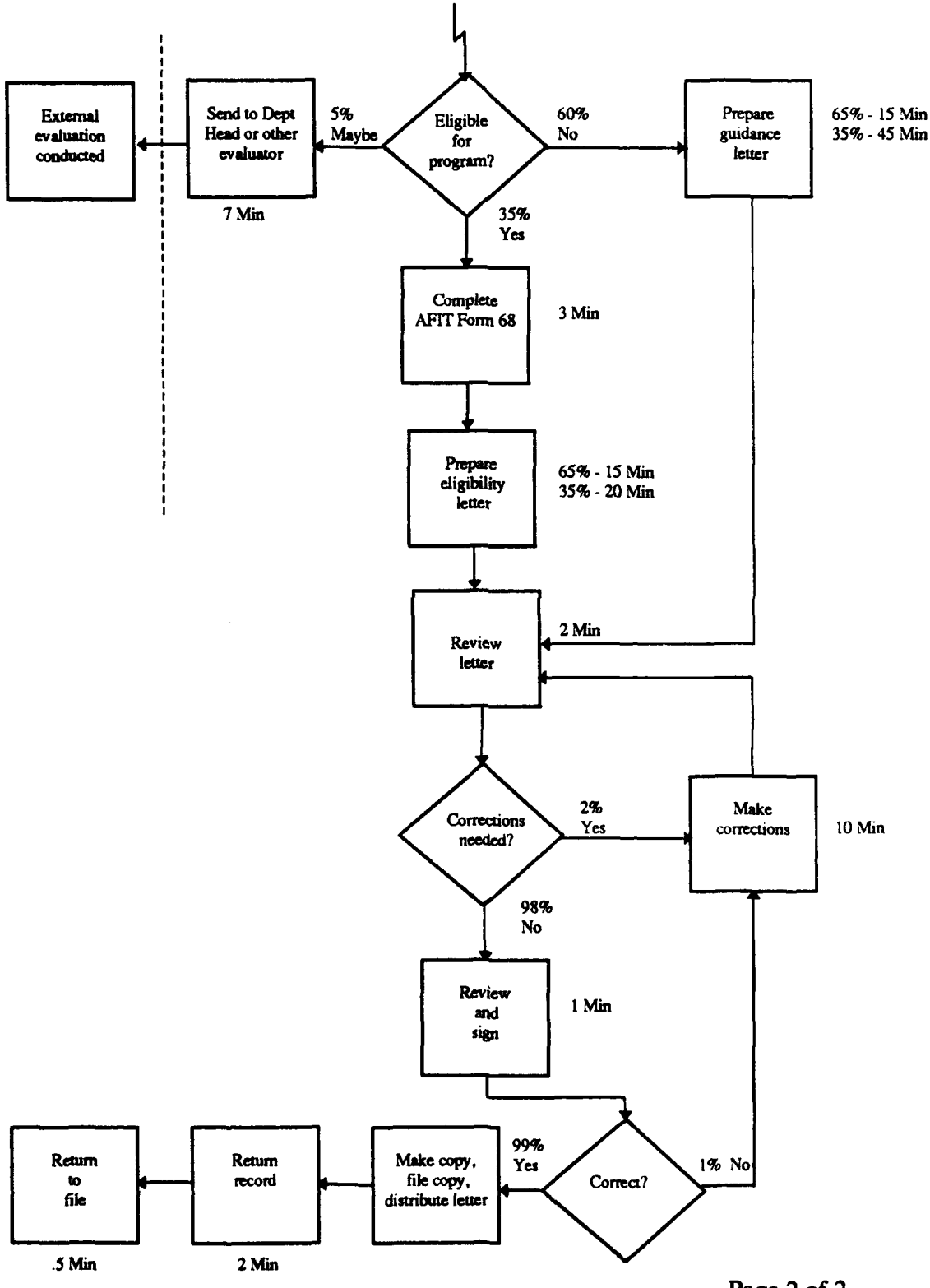
ROTC/AFIT Direct Accession



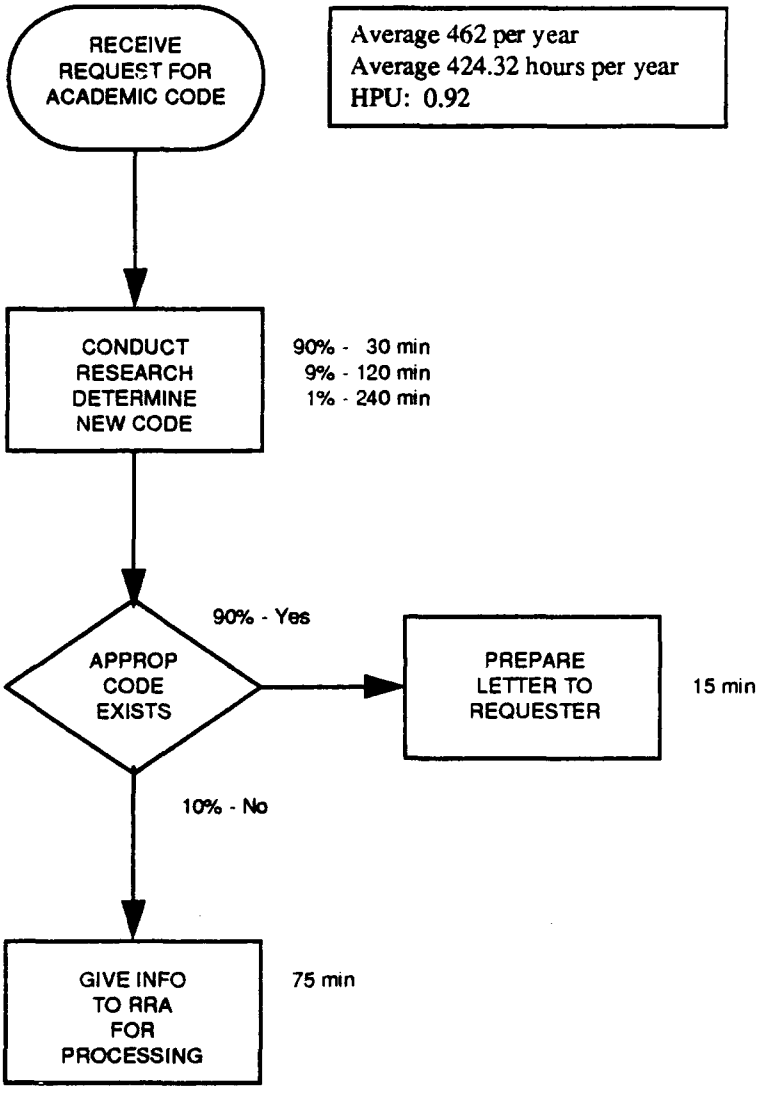
Program Eligibility Determination



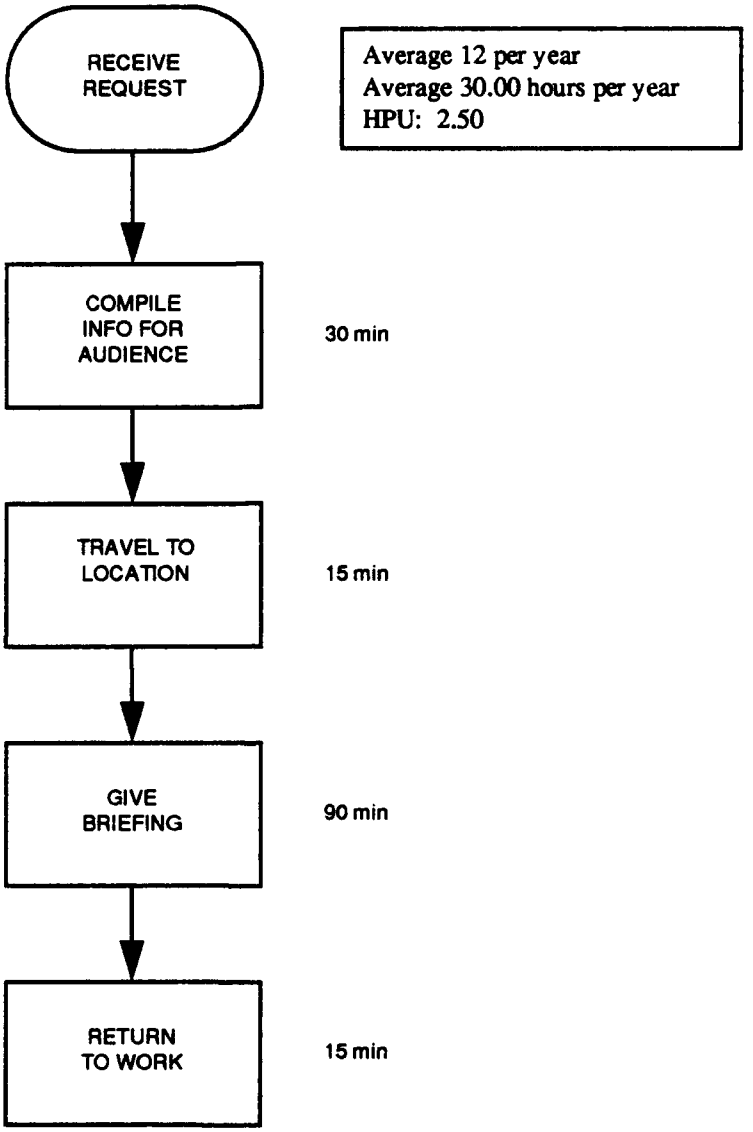
Program Eligibility Determination (cont)



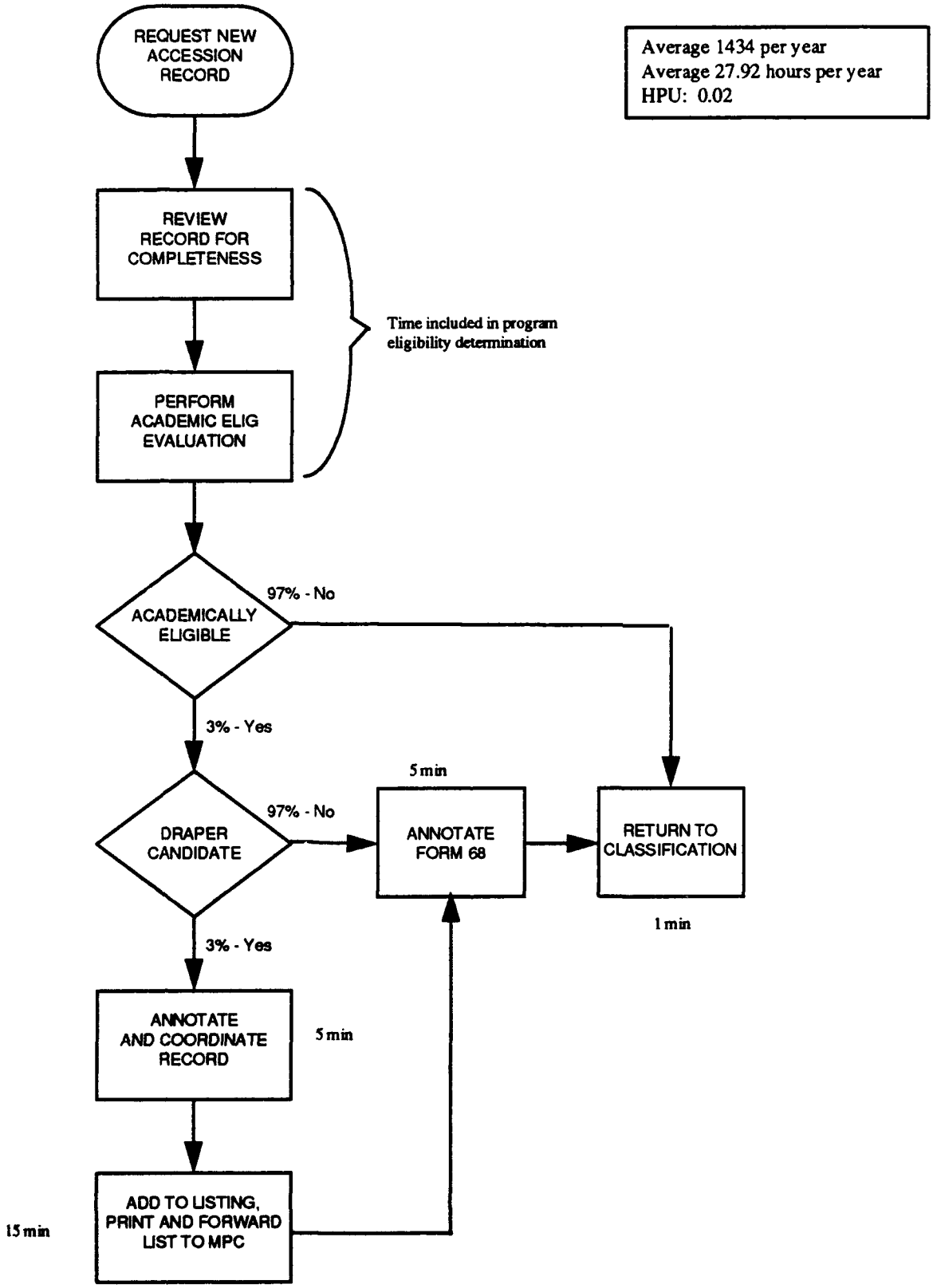
Academic Code Determination



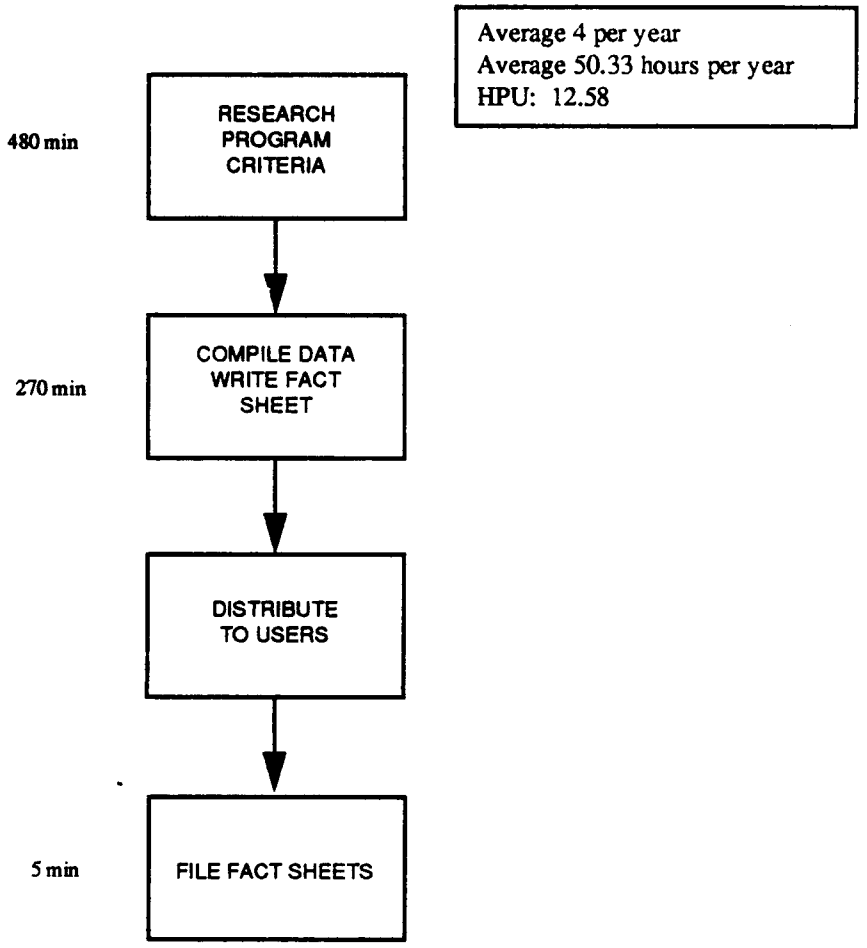
LOCAL AFIT PROGRAM ELIGIBILITY
ROTC BRIEFING



Perform Central Identification on Line Officers



Program Fact Sheets
(For Part Time Students)



Program Selection

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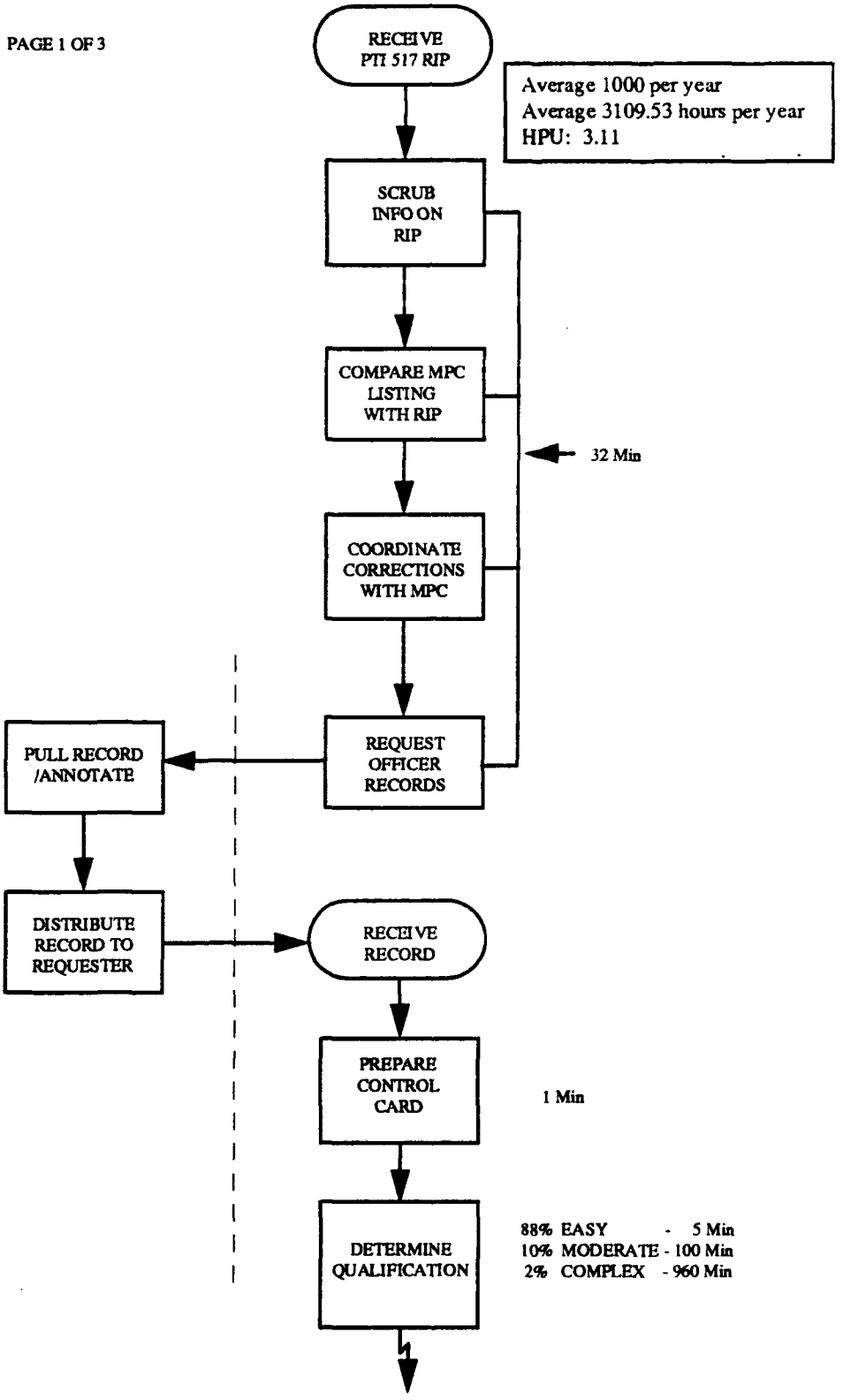

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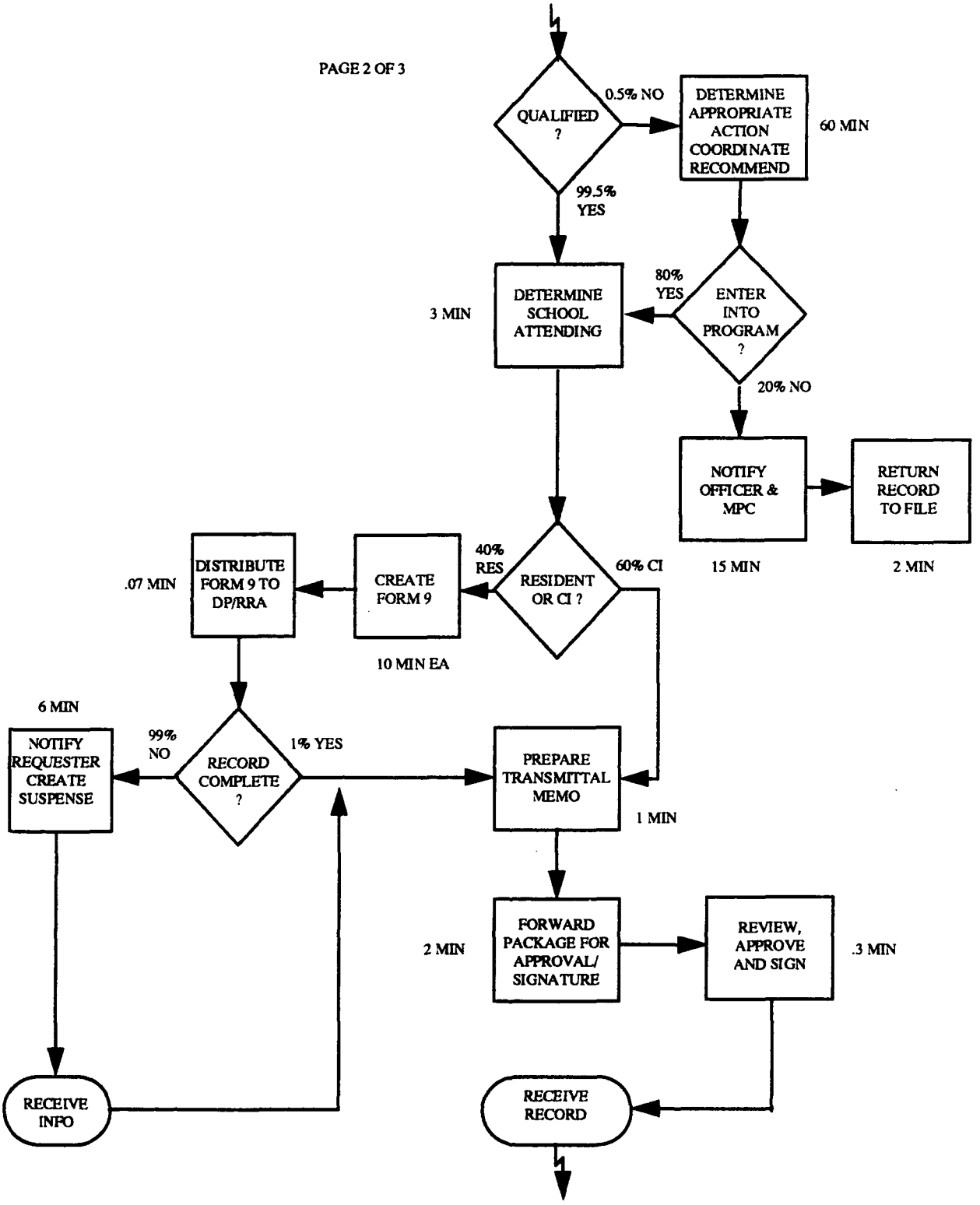

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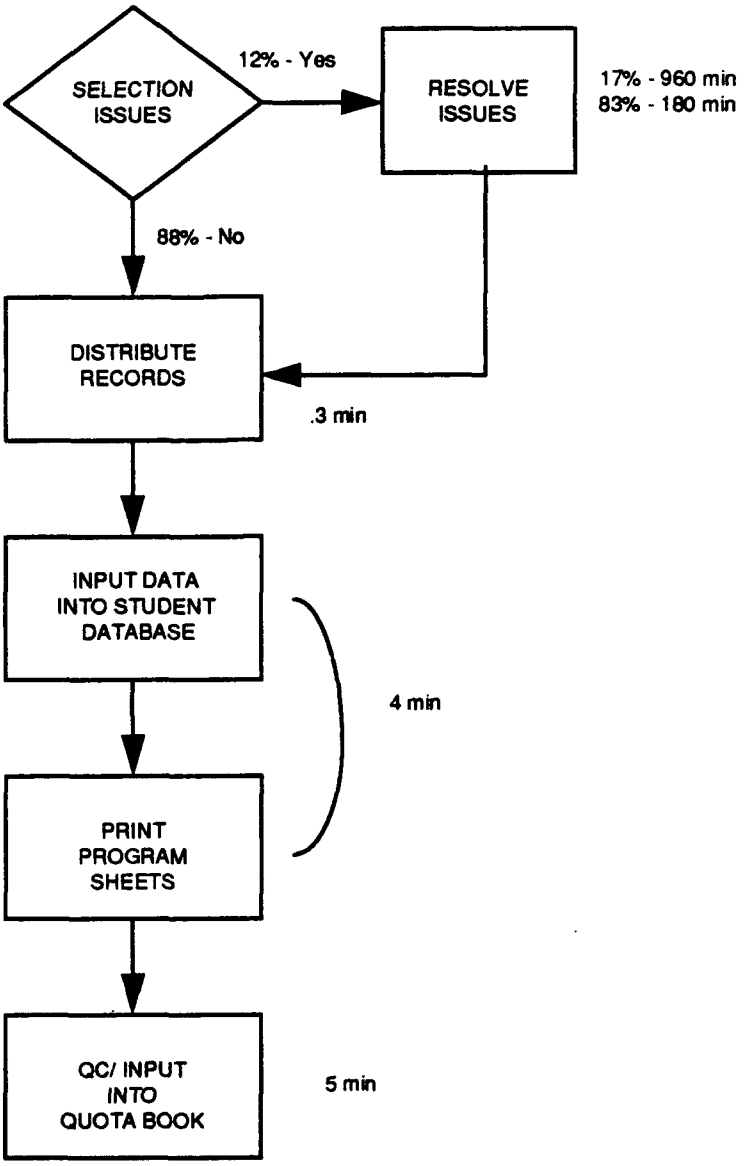
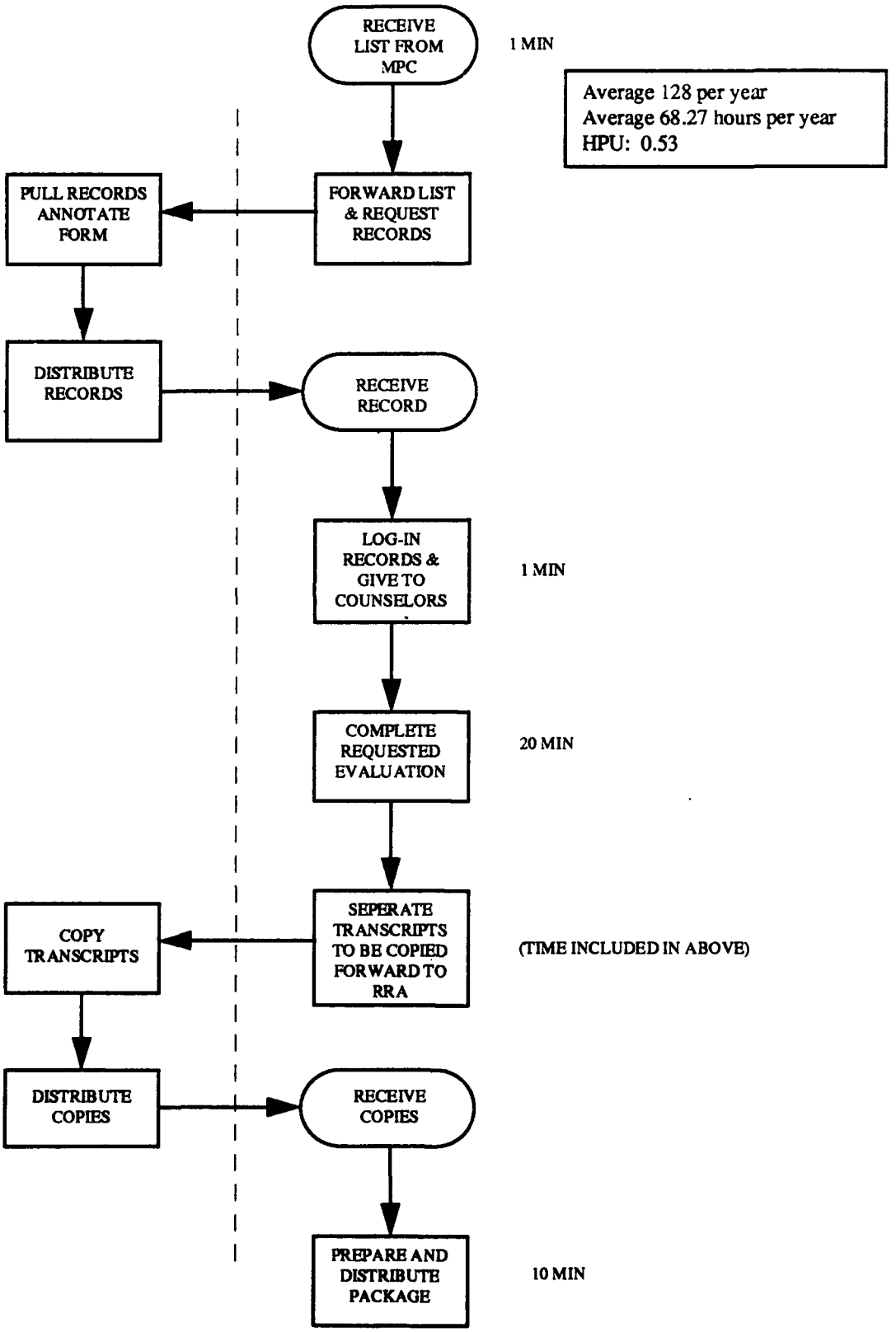
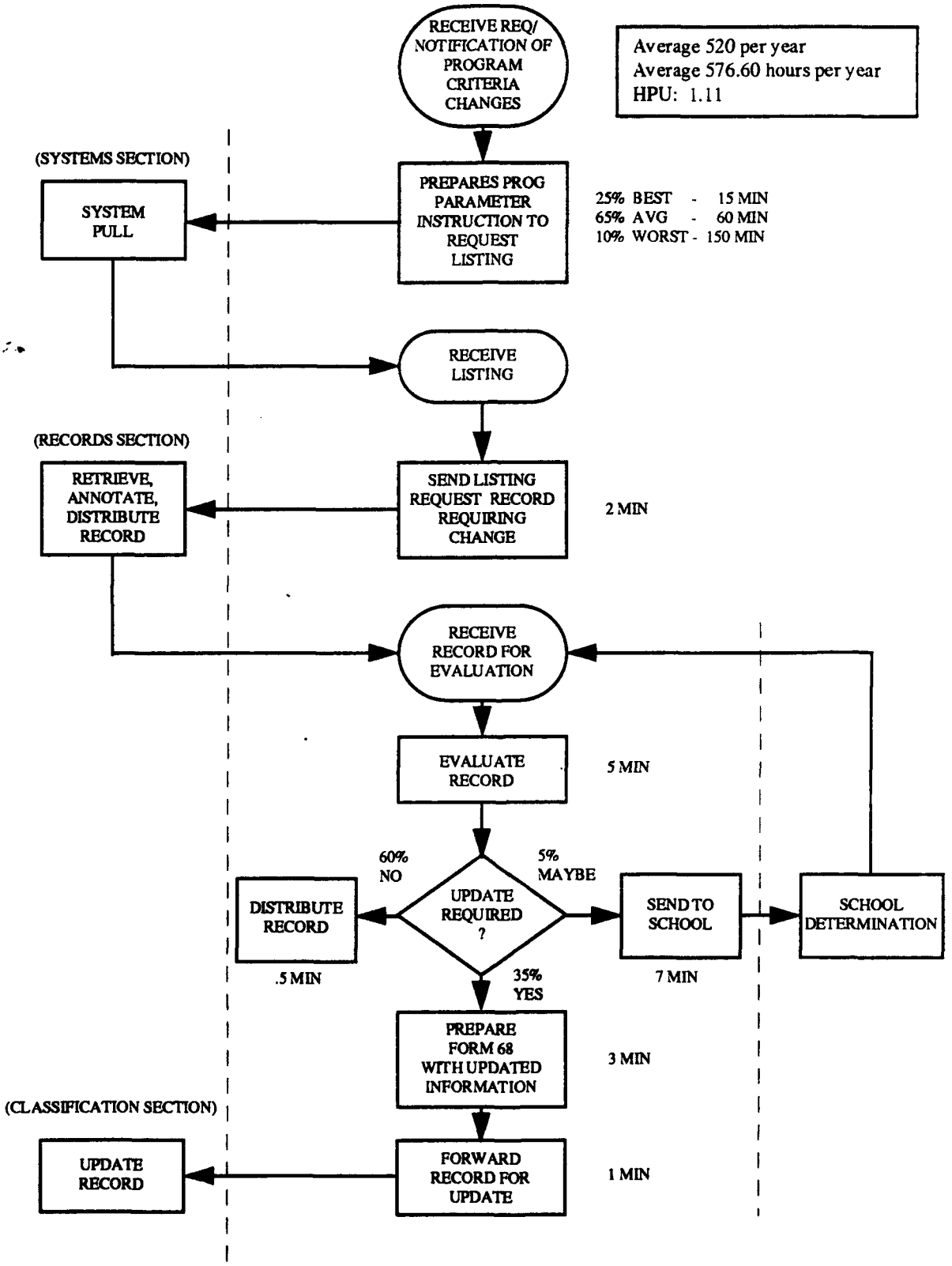


ROTC BOARD EVALS



CHANGE ACADEMIC ELIGIBILITY INFO



Bibliography

Air Force Institute of Technology. Statement of Work for the Image Processing and Retrieval System. Contract Number F33600-93-D-0173. Wright-Patterson AFB OH: AFIT/RR, 3 September 1993.

Byers, Timothy A. and Susanne M. Waylett. Measurement of Air Force Fire Department Productivity: An Evaluation of Efficiency/Effectiveness. MS thesis, AFIT/GEM/LSM/84S-4. School of Systems and Logistics, Air Force Institute of Technology (AU), Wright-Patterson AFB OH, September 1984 (AD-A146874).

Christopher, William F. Productivity Measurement Handbook. Stamford CT: Productivity Inc., 1985.

Department of Defense. Productivity Enhancement Measurement and Evaluation - Operating Guidelines and Reporting Instructions. DOD Instruction 5010.34. Washington: Government Printing Office, 4 August 1975.

Detachment 2, 3810 Management Engineering Squadron. "Air Force Institute of Technology Process Review Study." Report to the Commandant of the Air Force Institute of Technology, Wright-Patterson AFB OH September 1992.

Dykman, Charlene A. and Ruth Robbins. "Organizational Success Through Effective Systems Analysis," Journal of Systems Management, 42: 6-8 (July 1991).

Farina, Mario V. Flowcharting. Englewood Cliffs NJ: Prentice-Hall, Incorportated, 1970.

Funk and Wagnalls Standard Dictionary. New York: Harper Paperbacks, 1993.

Gaines, David A. and Trevor J. Nelson. An Analysis of the Records Management Process to Determine the Impact of Automation on Productivity. MS thesis, AFIT/GSS/LAR/93D-4. School of Logistics and Acquisition Management, Air Force Institute of Technology (AU), Wright-Patterson AFB OH, December 1993 (AD-A275923).

Gibson, Michael L. and others. "CASE: Clarifying Common Misconceptions," Journal of Systems Management, 40: 12-19 (May 1989).

Issues in White Collar Productivity. Norcross GA: Industrial Engineering and Management Press, 1984.

Koz, Joseph P., Commandant, Air Force Institute of Technology. "Future of the Air Force Institute of Technology." Address to Air Force Institute of Technology students. Air Force Institute of Technology, Wright-Patterson AFB OH 3 November 1993.

Lancaster, Ronald L. and Dennis D. Strouble. "One University's Approach to the Requirements of Academic Computing," Journal of Systems Management, 43: 19-20 (March 1992).

Lawlor, Alan. Productivity Improvement Manual. Westport CT: Quorum Books, 1985.

Leinfuss, Emily. "USAA's Image of Success," Datamation, 36: 77-82 (May 15, 1990).

Mundel, Marvin E. Improving Productivity and Effectiveness. Englewood Cliffs NJ: Prentice-Hall, Incorportated, 1970.

National Research Council. Measurement and Interpretation of Productivity. Report from the Panel to Review Productivity Statistics. Washington: National Academy of Sciences, 1979.

O'Rear, Floyd B. The Duties of the Registrar, An Analysis of the Work of the Registrars in Schools for Training Teachers in the United States, with a Development of Some Forms in Relation to Services Rendered. PhD dissertation. Southwest Missouri State Teachers College, Springfield MO, 1925.

Owen, Emerial L., Jr. The Collegiate Registrar: His Role in Illinois Higher Education. PhD dissertation. Saint Louis University, Saint Louis MO, 1967.

"The Payoff From Information Technology," Business Week, 3323: 130 (June 14, 1993).

Peterson, Wallace C. and Paul S. Estenson. Income, Employment, and Economic Growth (Seventh Edition). New York: W. W. Norton & Company, 1992.

Plesums, Charles A. and Ralph W. Bartels. "Large-Scale Image Systems: USAA Case Study," IBM Systems Journal, 29: 343-355 (Third Quarter, 1990).

Ruprecht, Mary M. and Kathleen P Wagoner. Managing Office Automation, A Complete Guide. New York: John Wiley & Sons, 1984.

Schriber, Thomas J. Fundamentals of Flowcharting. Huntington NY: Robert E. Krieger Publishing Company, 1980.

Sink, Scott D. and Thomas Tuttle. Planning and Measurement in Your Organization of the Future. Norcross GA: Industrial Engineering and Management Press, 1989.

Smith, Ben and Howard Eglowstein. "In Good Electronic Form," Byte, 18: 67-76 (November 1993).

Smith, Wilburn W. L. Implementing Information Systems/Office Automation in an Air Force Environment. MS thesis, AFIT/GIR/LSQ/87D-8. School of Systems and Logistics, Air Force Institute of Technology (AU), Wright-Patterson AFB OH, December 1987 (AD-A188956).

Strassmann, Paul A. Information Payoff, The Transformation of Work in the Electronic Age. New York: The Free Press, 1985.

Warren, Maj Hoyt M. The Benefits of Office Automation: A casebook, Student Report 86-2645. Air Command and Staff College (AU), Maxwell AFB AL, April 1986 (AD-A167825).

Vita

Captain Richard A. Bihary was born on 11 October 1961 in Dearborn, Michigan. He graduated from Mount Clemens High School in Mount Clemens, Michigan in 1979 and then attended Macomb County Community College for two years. After his sophomore year of college, Captain Bihary transferred to the University of Michigan - Dearborn where he graduated with a Bachelor of Science in Electrical Engineering in May 1984. Upon graduation, he entered Officer Training School and was commissioned an officer in the USAF on 29 August 1984. Captain Bihary's first assignment was in the System Integration Office (AFSPACECOM) at Peterson AFB in Colorado. As an Integrated Warning System Engineer, his main duty was to ensure the technical integrity of early warning systems that provide data to CINCNORAD/CINCSPACE and other command authorities. He also served as the executive officer to the Deputy Chief, System Integration Office. In August 1989, Captain Bihary was reassigned to the Foreign Technology Division at Wright-Patterson AFB in Ohio. There he served as a Collection Systems Program Manager. In this position he managed technical programs needed to collect data on foreign ballistic missile and aerodynamic systems for the Intelligence community. Capt Bihary entered the Graduate Systems Management program at the Air Force Institute of Technology in May 1993.

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Vita

Captain Roy C. Shrader was born on 31 July 1961 in Knoxville, Tennessee. He graduated from Hall's High School in Knoxville, Tennessee in 1979 and then attended Tennessee Technological University where he graduated with a Bachelor of Science in Electrical Engineering in June 1983. Upon graduation, he entered Officer Training School and was commissioned an officer in the USAF on 30 September 1983. Captain Shrader's first assignment was in the 2021st Communications Squadron at Tyndall AFB in Florida. As Deputy Chief, Communications-Computer Systems Support Office, he was responsible for providing communications and computer support for the Gulf Test Range. He also served as the Headquarters Squadron Section Commander for the 2021st Communications Squadron. In July 1987, Captain Shrader was reassigned to the 1942d Communications Squadron at Homestead AFB in Florida. There he served as both the Chief of Communications-Computer Systems Operations and the Chief of Communications-Computer Maintenance. In July 1990, Captain Shrader was assigned to Headquarters Tactical Air Command at Langley AFB, Virginia. In this assignment, Capt Shrader served as a Electronic Combat Requirements Engineer. In June 1992, he was reassigned to the Headquarters Air Combat Command Inspector General Team as a Communications-Computer Systems Inspector. Capt Shrader entered the Graduate Systems Management program at the Air Force Institute of Technology in May 1993. Upon graduation, he will be assigned to the Standard Systems Center at Gunter Annex of Maxwell AFB in Alabama and will manage the Center's local area network.

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The Air Force Institute of Technology Admissions/Registrar Directorate (AFIT/RR) has a need to improve and expand services using a smaller operating budget. One promising solution is to eliminate the paperwork required to perform the AFIT/RR functions. To assist AFIT/RR managers in evaluating alternatives, this thesis determines the nature and extent to which a paperless information system affects the productivity of the Air Force Institute of Technology Evaluations and Admissions Division (AFIT/RRE). The DOD definitions of productivity are used in this thesis. Based on these definitions, the hours per unit of work (HPU) is chosen as the measure of productivity. Baseline productivity measures are established by defining the work processes used by AFIT/RRE to accomplish their mission, determining that only a subset of the processes require measuring, and finally measuring the productivity of the selected processes. Next, identified paperless techniques are applied to the current information system to develop a representative paperless information system model. Measurements are remade using the paperless information system model. From comparing and contrasting the two sets of measurements, the extent is determined. The nature to which a paperless information system affects the productivity of the AFIT/RRE is provided by identifying paperless techniques.

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